EDITORIAL

THE concrete ship 'Faith' made two successful trial trips under her own power during the past month, one on San Francisco bay, and the other through the Golden Gate to the open ocean and back. A speed of 10 to 11 knots, or about 12 miles per hour was maintained. The 'Faith' is now making her first commercial trip with a cargo of salt to Puget Sound, and has reached Seattle in safety.

CAPITAL expenditures on the railroads amounting to $938,000,000 will be made in the near future, the money being used for additions, betterments, and equipment. Of this amount, about $125,000,000 is to be spent on Pacific Coast railroads. These expenditures are presumably entirely on work that the companies have wished to do for some time, but could not obtain the money as long as the railroads remained in private hands, particularly since, being in private hands, rates could not be raised as they soon will be.

ANEROID barometers, sextants, and chronometers are needed by the United States Navy for the equipment of vessels now being placed in commission. The same plan is being followed as for binoculars and telescopes, for which a call was issued some time ago. The owner's name and address is taken and the instruments will be returned to him at the end of the War, unless they have been lost. Many engineers own such instruments and seldom if ever use them. Here is an opportunity to put them to real service and help to win the War. Instruments may be sent to the United States Hydrographic Office, Merchants Exchange building, San Francisco.

RURAL motor-express lines are favored by the Highways Transport Committee of the Council of National Defense, primarily to assist in the production of foodstuffs. By means of a return-loads organization, farm products of all kinds may be shipped to the cities, and implement-parts, seed, fertilizers, and other supplies brought back on the return trip. One of the main advantages of the rural-express system is that it reduces labor. In some places the hauling formerly done by five men with wagons is now done at considerably greater speed by one man with a truck. Most of the express lines now in operation are run by private individuals that are acquainted with local conditions.

OIL companies that are formed to sell stock and not to produce oil have received a sudden shock in Denver. As has happened so often in other oilfields, the legitimate activities in oil development in Wyoming and Kansas have caused a mushroom growth of stock-jobbing concerns to spring up and, most unfortunately, to flourish, to the detriment of both the savings of the people and the real business of producing oil. Colorado has no blue-sky law, and the centre of these stock-selling activities has consequently been Denver. Recently the Denver authorities passed an ordinance instructing one of the city officials to investigate and report upon companies and brokers selling oil-stock in the city. The reports of this official on the first five or six companies investigated, as printed in a recent number of the 'Western Oil World,' are far from flattering. While no legal action has been, or can be taken, the mere publication of the facts is having a discouraging effect on stock-jobbing concerns.

NORTHERN ELECTRIC COMPANY has been sold under foreclosure to a committee representing the bondholders, who will now take charge of the company's electric railroad system. The system has for some time been operated at a profit under the direction of Mr. John P. Coghlan, who has been receiver for the past four years, and who will probably be appointed president of the new company. Perhaps the most remarkable feature of the receivership and reorganization has been the small size of the attorneys' fees, which amounted in all to only $43,000. If this sort of fee is to become the general rule, it will be possible for valuation engineers to revise their allowances for 'legal overhead.'

PRICES of fuel-oil, gasoline, kerosene, and 'aviation naphtha' for supplying the Allies have been fixed by United States Fuel Administration at both Atlantic and Gulf ports. In accordance with the policy announced by the Fuel Administration of not interfering with the industry except when necessary, these prices do not apply to domestic consumption, but, since the Allies buy in large quantities, it is probable that prices to all consumers will be affected. The price of gasoline is fixed at 23½ cents per gallon at Atlantic ports and 21 cents at Gulf ports. Aviation naphtha, which has a gravity of 62° Baumé and a final boiling-point of 302° Fahrenheit, is to cost 32 cents per gallon at Atlantic ports and 30 cents at Gulf ports. Fuel-oil is to cost $3.15 per barrel at Atlantic ports and $2.31 at Gulf ports, and kerosene 8¼ cents and 7½ cents per gallon, respectively. It is hardly likely that this price-fixing order will have even an indirect effect upon Pacific Coast conditions.

'COAL WEEK' is from June 3 to June 8. Special efforts are to be made all over the country during this week to persuade the consumer to do his winter shopping, as far as coal is concerned, early. The experience of last winter taught the country that coal pro-

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duction must be kept at a maximum throughout the year and must not be reduced during the summer, when demand is relatively light. Storage is the only means by which this can be accomplished. While large quantities of coal can and will be stored at the mines and at distribution-points, the best place to store coal, and the only place where it will surely be ready when the time comes, is in the bins of the consumer. Furthermore, storage by the consumer will not, in general, make such a demand upon the credit resources of the Nation at large as would storage by either the producer or the dealer. Few Pacific Coast residents are large consumers of coal, but even the small amount required for domestic use had better be ordered early.

COUNTY fire-departments, such as were advocated in these columns last year, are being organized in many of the counties of California, primarily to prevent damage to pasture and growing crops. The general plan follows suggestions made by Mr. G. M. Homans, State Forester, who is co-operating with the United States Food Administration and the California Cattlemen's Association, and is similar to that adopted and found successful in Solano county last year. Each county is divided into several districts with a volunteer fire-company in each district. At some central point in the district an automobile trailer is stationed, loaded with fire-extinguishers and other simple fire-fighting equipment, the entire outfit costing only a few hundred dollars, which is paid from county funds. With the aid of the telephone and the automobile both firemen and equipment can be brought to a fire in a relatively short time. Some counties have also appointed fire-wardens to serve on full time during the summer and fall, and to have general charge, not only of fire-fighting, but also of fire-prevention measures, such as the plowing of fire-breaks, equipment of harvesting-machines with spark-arresters and fire-extinguishers, etc. The shortage of rainfall has reduced the available supply of both grass and grain, making it particularly important to save what is left, and at the same time increasing the danger of loss by fire.

MOSQUITOES have a very definite connection with engineering as most surveying parties can testify. However, it is only in recent years that mosquito-prevention has become a question of engineering. Among the many semi-municipal organizations authorized in California are mosquito-abatement districts. The annual report of the Bakersfield district, which includes that city and a considerable area of irrigated agricultural land adjacent to it, has recently appeared. The district has a population of nearly 20,000 and assessed valuation of several million dollars. As a result of the abatement work both the number of mosquitoes and the number of cases of malaria have been materially reduced. The annual cost of this work is only about $12,000. During the fall and early winter, men are kept at work opening drainage channels and filling holes that might otherwise become mosquito-breeding pools. At the commencement of the breeding season in February oiling of pools is begun and is continued during the spring and early summer. The report recognizes that permanent control of the nuisance will not be possible until the irrigation ditches throughout the district are lined with concrete and until the channel of Kern river is dredged. There is room for considerably more of such mosquito-prevention work in various districts on the Pacific Coast. It will pay for itself in increased health as well as increased comfort of the communities affected. Only recently it has been reported that the output of a certain Pacific Coast shipyard was seriously affected by the mosquito nuisance, not only because workmen did not want to stay on the job and be eaten alive, but also because the efficiency of the men that did stay was reduced. Thus the mosquito, like so many other pests, is seen to be an ally of that arch-pest, the Kaiser.

TWO city managers in Californian cities have resigned during the past few weeks, Mr. J. A. Hinman of Hanford, and Mr. T. H. Reed of San Jose. The reasons for Mr. Hinman's resignation appear to be simple. The people of Hanford may have thought that they were adopting a charter providing for the appointment of a city manager, but in reality the so-called manager was given relatively little power, and was little more than a combined foreman and purchasing agent. Soon after taking office, Mr. Hinman found that the city council, probably in entire good faith, intended to retain many administrative functions to itself. After several months of friction between himself and the council, Mr. Hinman resigned. Mr. Reed, on the other hand, while professor at the University of California, helped to draft the charter under which he was later appointed city manager of San Jose. He had plenty of power and he used it. Naturally, he made many enemies. One or other political move either to hamper him or to remove him entirely was under way during most of the two years of his administration. The plan that appears to have been finally successful was probably not dictated entirely by opposition to Mr. Reed. On account of the loss of revenue caused by closing the saloons and the general increase in municipal expenses, an increase of the tax rate above the limit set by the charter was proposed. This the people refused to approve, while at the same election they voted in favor of an increase of pay for many municipal employees. An amendment to the charter was proposed at a later election that, by requiring a five-year residence for municipal employees, would have automatically removed Mr. Reed from office. He retained his position until after this amendment had been defeated and then resigned, leaving the council and the citizens in general to struggle with the problem of municipal finance. While Mr. Reed has probably made mistakes during his term of office, there can be no doubt of the general improvement in municipal conditions in San Jose as a result of his administration. One man cannot carry the burdens of an entire city, but a capable city manager can, with the co-operation of the citizens, accomplish much in the direction of an efficient city government.

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REVIEW OF THE MONTH

ROAD-OIL, asphalt, and tar products will hereafter be delivered to consumers only upon approval of the application by a committee representing the United States Fuel Administration and the United States Office of Public Roads. State Highway Departments are required to pass upon all applications for highway work in their territories involving the use of these materials. Applications are then to be forwarded to Mr. L. W. Page, Director of the Office of Public Roads. Mr. Page's committee will make recommendations to the petroleum division of the Fuel Administration, which will issue the necessary permits. The supply of bituminous products is relatively so small that a request has been made for the postponement of all new road construction requiring these materials until after the War, except where such work is necessary for the winning of the War. Preference will be given to materials needed for maintenance and repair work.

PREPAREDNESS for Peace was advocated by Mr. Franklin K. Lane, Secretary of the Interior, in an address delivered recently at Los Angeles. He proposed reclamation of arid land, swamp land, and logged-off land after the War, largely by the use of the labor of returned soldiers, paying them, in part at least, by giving them developed farms from the lands so reclaimed. At the present time we are finding difficulty in producing enough food for our Allies as well as ourselves, in spite of the fact that there is a large amount of idle land in nearly every State in the Union. While there are many reasons for this condition, the principal one is that most of this land falls into the three classes already mentioned and would require for its reclamation a larger amount of capital or credit than the individual, or even the private company, can obtain. This capital or credit the Federal Government can supply. The experience of the Reclamation Service, its failures as well as its successes, may well be studied in making plans for this work. Mr. Lane recommended the immediate appointment of experts to consider the problem from all sides and to prepare plans so that actual construction can be commenced at the close of the War. Reclamation of this land, whether logged-off, arid, or swampy, is primarily an engineering proposition, and will offer many opportunities for useful service to engineers.

CALIFORNIA oil production for April was the largest of any month since December 1914, but nevertheless the drain on storage continues at an alarming rate. However, there is more hope of a settlement of the leasing question, permitting development of the withdrawn lands, than at any time since the first withdrawal order nearly nine years ago. A leasing bill has passed both Houses of Congress and is at the present writing in conference. The most important part of the bill provides for leasing wells already drilled on withdrawn lands to the claimant and authorizes the President at his discretion to lease the remainder of the claim to the claimant whenever public necessity demands such action. The minimum royalty, which was originally fixed at one-fourth, has been reduced to one-eighth. The two Houses have disagreed as to whether or not these leasing provisions should apply to land within the naval reserves, and the naval reserves will probably be the principal point of contention in the conference, as has been the case throughout the entire discussion of leasing legislation. However, it is probable that some solution will be found, and the bill may even go to the President and become a law before this reaches our readers. The question of the development of Naval Reserve No. 2 at least is important, since, as has been shown several times in these columns, that reserve is the best place in the State for development with a view to obtaining a large increase of production with a relatively small expenditure of labor and material. The only argument against such development is that the oil in this reserve should be kept for the Navy, which may never need it, and which, in any case, has shale land reserved for it in Colorado and Utah that is estimated to contain over a billion barrels of oil.

LAND in the Elk Hills district will probably be retained by the Southern Pacific Company as a result of a recent decision of the Circuit Court of Appeals. This land, comprising about 6000 acres in odd-numbered sections, was patented as agricultural land in 1903 and 1904 and was the last of the railroad-grant lands in the San Joaquin valley to be patented. At the time patents were issued a considerable commercial production was being obtained from the McKittrick field about ten miles west, as well as some oil from both the Midway and Sunset fields to the south. In 1910, just before the statute of limitation would intervene, the Government brought suit to cancel the patents, alleging fraud in obtaining patent in that the land was known to be mineral. The case was decided in favor of the Government in the District Court by Judge Robert S. Bean. This decision has now been reversed in the Circuit Court by Judges Frank Deitrich and William S. Hunt, Judge W. B. Gilbert dissenting. No oil has been shipped from the Elk Hills district, although the Associated Oil Company obtained oil from several wells drilled in 1910 and 1911 on some of the even-numbered sections adjoining the land involved in the present suit. The decision upholds the contention of the company's counsel that mineral land in the sense con-

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templated by the law meant land known at the time patent was issued to be commercially valuable for oil or other minerals. The Court rejects the theory of the Government that the existence of geological evidence that oil was probably present on the land was sufficient to make it mineral land within the intent of the law. The Government will probably appeal the case to the Supreme Court, both on account of the importance of the case itself, and also because of the effect of the decision on the other suits now pending to recover oil-bearing land from the Southern Pacific Company. The Government's case in the Elk Hills suit is considerably stronger than in any of the other suits. In the first place, as already noted, the statute of limitations does not enter into the case. Secondly, unlike the land in the other suits, patents to the Elk Hills land were issued years after the oil industry had become important in California, and after the general adoption of oil as fuel by the railroads of the State, including the Southern Pacific Company. Finally, at the time patents were issued there were many producing wells within a few miles of the land.

FREIGHT and passenger rates are to move skyward, the former on the 25th, and the latter on the 10th of this month. Passenger fares are to be figured at 3 cents per mile for ordinary day-coach accommodations, 3¼ cents for tourist cars, and 3½ cents for standard-sleeper and parlor cars, in addition to the regular Pullman charges. The war tax is to be added to all these rates. This is not going to affect travelers on the Pacific Coast, where most fares are now approximately on a three-cent basis, as much as it will those in some of the Eastern and Middle Western States, where traffic is heavier and fares are frequently lower. Excursion rates are also to be higher and fewer, and even the lowly commuter is to contribute 10% additional. More important, however, than the increase in the passenger rates is the increase of freight rates, amounting on an average to at least 25%, and which must in the end be absorbed in the prices of commodities. The largest proportionate increases are for the relatively short hauls, amounting in some instances to as much as 150%. Whether or not this will increase the use of motor trucks for short-haul freight remains to be seen. Perhaps the rates were fixed with this object in view, although no statement has been made to that effect. Besides products hauled a short distance, the largest increases in cost to the consumer will be for the bulky products, such as coal, hay, grain, and building materials of all kinds. The new rates are expected to increase the yearly revenue of the railroads by about $800,000,000, to offset an estimated increase of operating expenses of the same amount, the principal item of this increase being $300,000,000 more for wages and $160,000,000 more for coal. This is probably the largest direct addition to its living expenses that the public has had to face at any one time, and it is interesting to compare the relatively calm manner with which it has been taken with the uproar that greeted the proposal for a much smaller increase a few months ago, when the railroads were still in private hands. The position of the State railroad commissions is, however, the most remarkable thing in connection with the whole affair. Although intrastate as well as interstate rates are affected, the only recognition that the commissions receive is a polite invitation to make suggestions for adjustment of rates.

WAR needs v. legal red tape and similar obstructions have already been discussed in these columns. A recent instance where the war needs triumphed was furnished in Yolo and Lake counties. Cache creek, the outlet of Clear lake, furnishes the principal supply for irrigation of land in Yolo county in the vicinity of Woodland, the water being supplied through the canals of the Yolo Water & Power Company. The use of water for irrigation has increased materially in the last few years on account of the commencement of rice culture. There has already been considerable discussion and some litigation between the Yolo Water & Power Company and the riparian owners on Clear lake regarding the amount of water that the company should be allowed to draw from the lake. Partly on account of the increased use of water during 1917 but mainly because of the small rainfall and small resulting runoff during the past season it became evident that no water would be available for the late irrigation that is essential to successful rice-culture unless water could be withdrawn from the lake until it was considerably below low-water mark. Besides requiring an expensive pumping-plant this could not be done legally without the consent of the riparian owners on the lake. Through the efforts of representatives of the Federal Food Administration, an agreement has been signed by all concerned that will permit the rice-farmers to obtain the necessary water. The riparian owners will allow the lake-level to be lowered to a point three feet below low-water mark, the Yolo Water & Power Company agrees to construct a pumping plant on the lake to pump water into Cache creek, and the rice-farmers agree to pay an extra charge of $4 per acre, half of which is to go to the company to reimburse it for the cost of construction and operation of this plant, and the other half is to be turned over to the Federal Food Administrator to be distributed among Lake County interests as he may deem just and proper. The best part of these war agreements is that while they are all expressly limited to this year, they usually point the way to a saner method of running things in future than has been the rule in the past. In the present instance, everyone agrees that the rights of the riparian owners on Clear lake should be considered in making use of the waters of the lake. On the other hand, it is equally true that, during many seasons at least, part of the water in the lake is of more value to the farmers of Yolo county than to the riparian owners. It may be difficult, but it ought not to be impossible, to make a permanent arrangement for use of the lake water when needed, payments to be made in proportion to benefits received by the farmers and to damages sustained by the owners of property on the lake.

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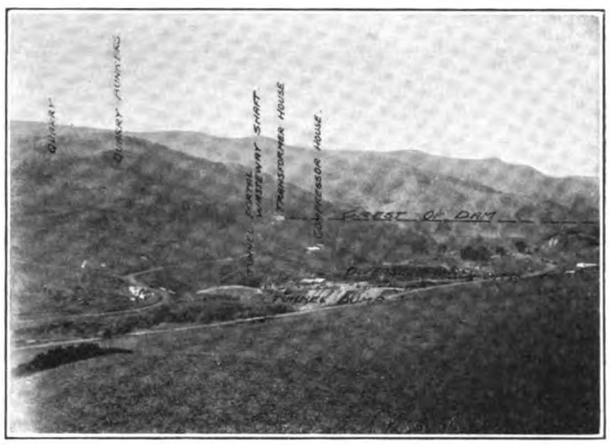
The San Pablo Dam

In order to increase the supply of water available for Oakland and the other cities on the eastern side of San Francisco bay, the East Bay Water Co. is constructing the San Pablo project. This consists of a dam in San Pablo canyon about six miles south-east of the city of Richmond, and a tunnel from the canyon through the Berkeley hills, the western portal being near the northern limits of the city of Berkeley.

Fig. 1 shows a map of the dam and vicinity and Fig. 2 is a cross-section. The dam will have a crest-length of 1350 ft. and a maximum height of 165 ft. above the original ground-surface. It will contain 1,400,000 cu. yd. The dam is being constructed by the hydraulic-fill method. It is expected that about 50% of the material will be a hydraulic fill composed of sand, clay, shale, and silt and the remaining 50% will be rock excavated by steam-shovels and transported to the work in wagons and dump-cars.

Clearing and stripping the site was commenced in September 1916. Unsuitable surface-material amounting in all to 52,300 cu. yd. was excavated by steam-shovels and transported in wagons to a dump away from the dam-site. In exploring the foundation conditions, diamond-drill holes and short tunnels as shown in Fig. 1 were driven. Bedrock, an indurated shale, was found to be from 10 to 15 ft. from the surface except for a distance of about 460 ft. along the axis of the dam and in the channel of San Pablo creek. On this part of the work the depth to bedrock was about 48 ft., the intervening material being alternate layers of mud, gravel, and sand. Two cut- off walls have been constructed, one for the diversion-dam, and one for the main dam. The



VIEW OF DAM-SITE IN NOVEMBER 1916, SOON AFTER COMMENCING WORK

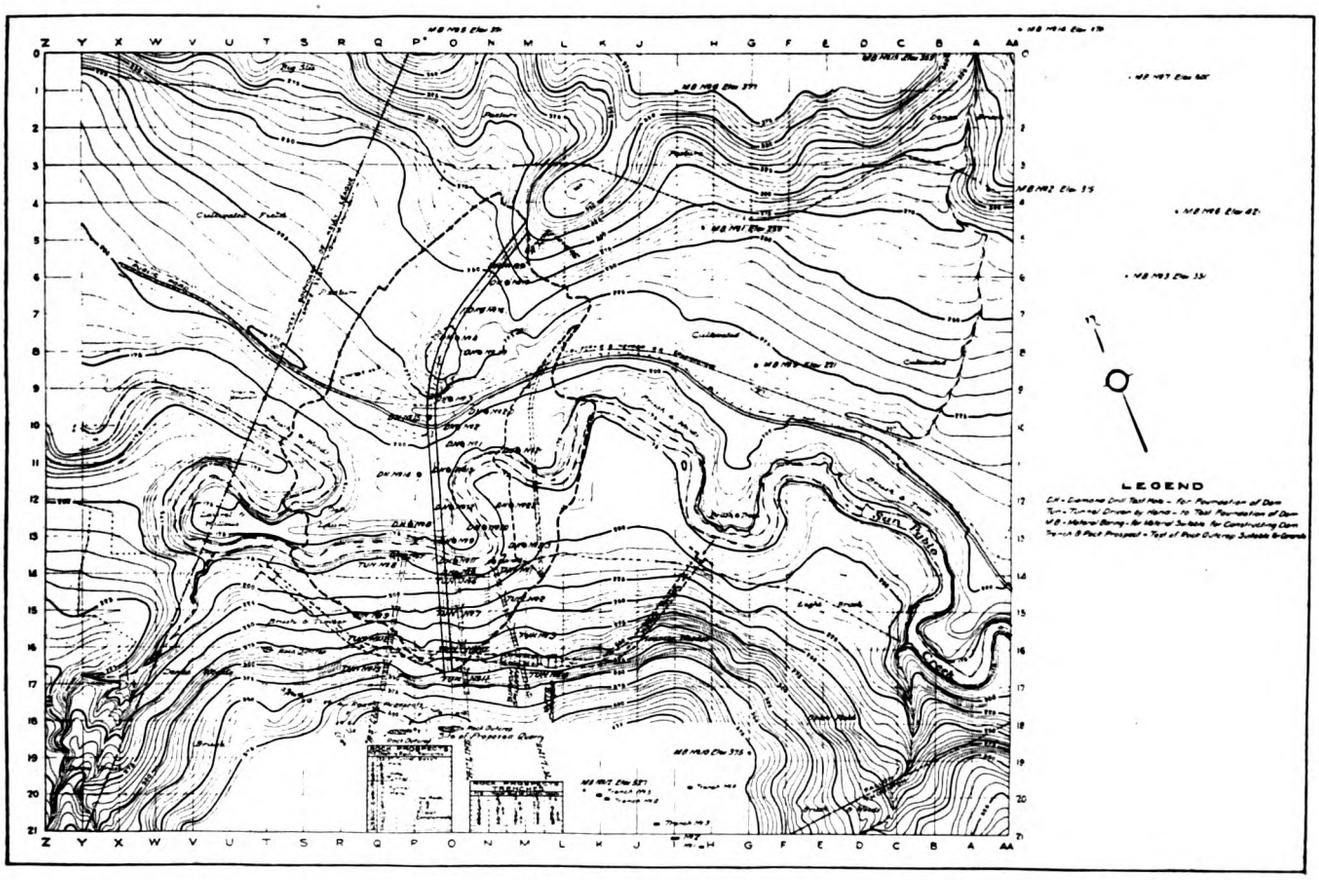


FIG. 1. MAP OF DAM-SITE

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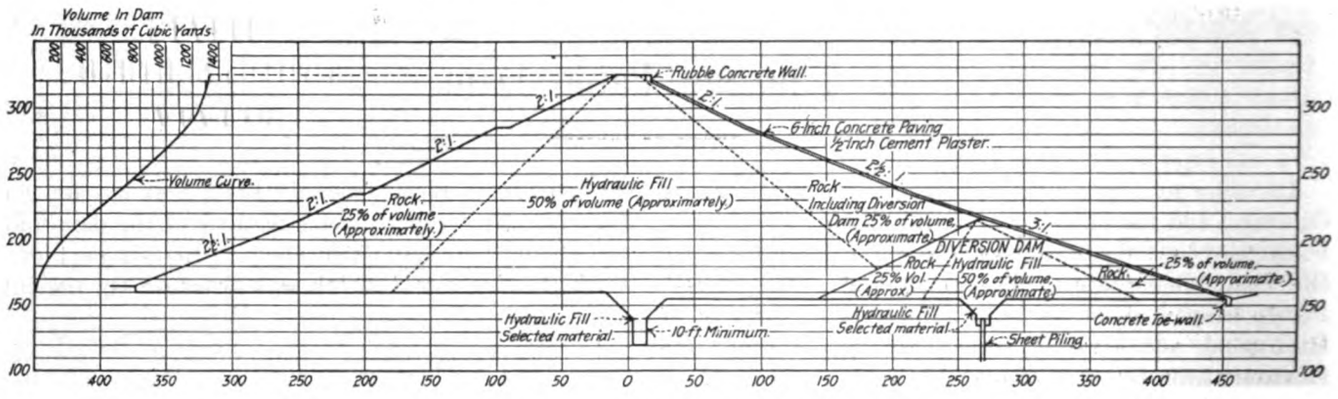

FIG. 2. CROSS-SECTION OF DAM

object of constructing the diversion-dam wall was to prevent as far as possible loss of stored water by subterranean flow, and also to prevent increased flow into the core-wall excavation of the main dam. A puddle-trench was excavated and 7626 lin. ft. of 4 by 10-in. Wakefield sheet-piling was driven along the axis of the dam.

The core-wall trench for the main dam was excavated with steam-driven orange-peel dredge that 'straddled' the trench, running on rails laid on each side of it. The dredge opened a 5-ft. cut at the north end of the creek section. This cut was continued to the south end, the grade of the bottom of the cut being just sufficient to permit the seepage-water to flow to the north end. An electric-driven pump was placed here to handle the water. Wooden sheet-piling 3 by 6 in. was driven behind the dredge. The dredge moved back and forth along the trench, followed by the pile-drivers, until the trench was excavated to the maximum depth of 48 feet.

A permanent spillway is provided by a wasteway tunnel through the hill at the southerly end of the dam. The inlet is 100 ft. upstream from the main dam and the outlet is 150 ft. below the dam. The floor of the tunnel is at the same elevation as the bottom of the reservoir. The tunnel is circular, 14 ft. 6 in. diam. and 1375 ft. long, of which 1060 ft. is on a tangent. The capacity with the dam completed and the reservoir full will be 10,000 cu. ft. per second, and with the head afforded by the diversion-dam, 4000 cu. ft. per second. Besides serving as a spillway, the tunnel will contain an 18-in. cast-iron pipe-line to be used to supply the city of Richmond, and can also be used as a silt blow-off after the reservoir has become partly filled with silt. There are three 5-ft. sluice-gates for blow-off purposes.

In driving the tunnel in caving-ground a small drift was driven for the wall-plates of the tunnel-arch and a heading was then driven approximately the size of the tunnel-section above the springing-line. After this the bench was removed. In solid rock the wall-plate drifts were not necessary. The material was hauled in one-yard cars running on a track laid on the invert of the tunnel. The material from the headings was loaded into wheelbarrows and dumped directly into the cars. Blasting was required on all the work. In the heading, 12 holes were drilled to the round and the same number in the bench. The number of shifts was three, 12 men working on a shift. The tunnel was lined with concrete 2 ft. thick. Overbreakage was filled with concrete and the seams were grouted. The concrete was placed by the pneumatic method, a 6-in. pipe being used. Aggregate was obtained from a quarry on the hillside above the tunnel, all materials being handled by gravity. The tunnel proper required 16,000 cu. yd. excavation, 425,000 ft. B.M. lumber for timbering, 7000 cu. yd. concrete, 1250 cu. ft. grout, and 300,000 ft. B.M. lumber for forms. The portals required 10,000 cu. yd. excavation, 1500 cu. yd. concrete, and 38,000 ft. B.M. form-lumber. A 1:2 mixture was used for the grout and a 1:7 mixture for the concrete.

A gate-chamber comprising an elliptical transition-section 70 ft. long was constructed 500 ft. below the intake of the tunnel. This gate-chamber contains three cast-iron ribbed and flanged tubes 5 ft. diam. set in concrete and having cast-iron sluice-gates for controlling the flow of the tunnel. The three 5-ft. gates are primarily for the purpose of blowing off silt and can also be used as an auxiliary to the main spillways. The gates are operated by stems 4½ in. diam. and 165 ft. long connected to low worm-geared lifts in the gate-house. The gates are designed to operate under the full reservoir-head and against a lateral pressure of 85 tons. The gate-stems are set in holes, drilled with a well-boring rig, and lined with 10-in. cast-iron pipe and 8-in. casing, the space between being filled with concrete. Down-stream from the gate-house a circular shaft, 14 ft. 6 in. diam., 165 ft. deep, and lined with 2 ft. of concrete was sunk to connect with the tunnel. This shaft is provided with an over-pour lip at the elevation of the high-water line of the reservoir, and will serve as a relief spillway to handle flood-flows.

To handle possible flood-flow in excess of the capacity of the wasteway tunnel under the relatively low head provided by the diversion-dam, a temporary spillway with a capacity of 8000 cu. ft. per second was constructed toward the northerly end of the main dam. A cut 40 ft. wide and having maximum depth of 20 ft. was made in the ridge, using a revolving steam-shovel and motor trucks. The total length of the cut was 1000 ft. and the amount of material excavated was 24,000 cu. yd., most of which was used in the main fill for the dam. Con-

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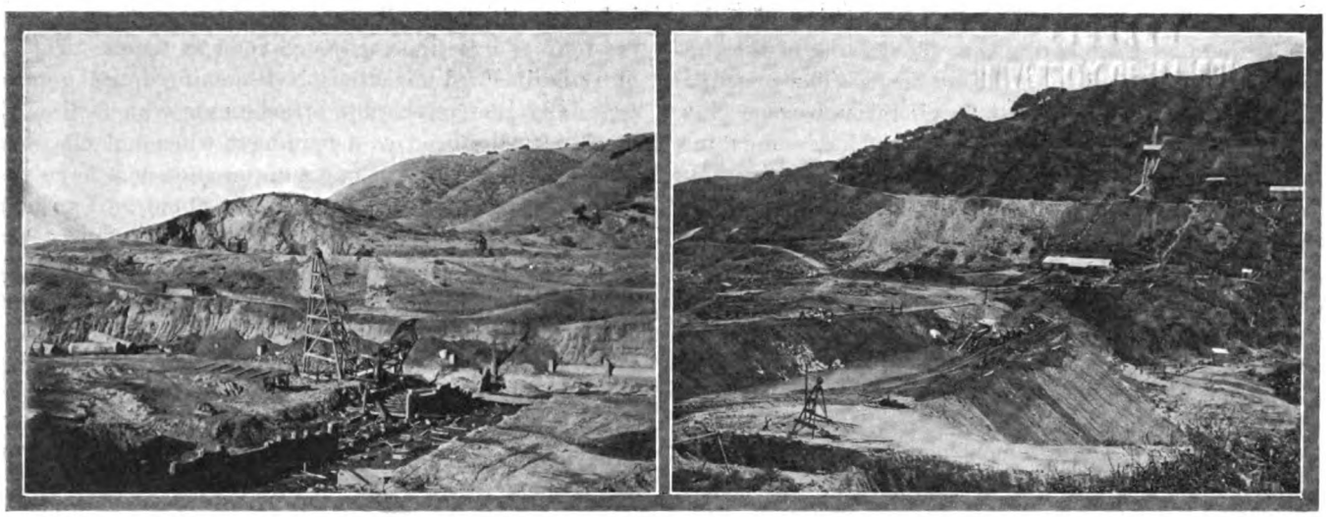


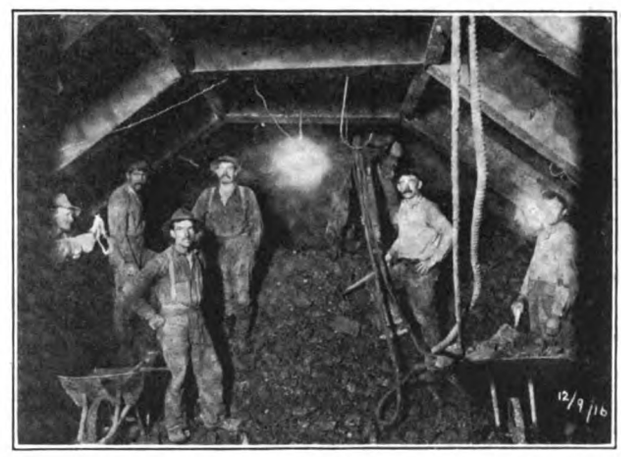
DRIVING PILING FOR CUT-OFF WALL OF DIVERSION-DAM, AND DIVERSION-DAM SOME MONTHS LATER

crete headworks, arranged to contain stop-logs, were constructed 250 ft. below the intake of the cut. From the headworks to the intake the section was 40 ft. wide on the bottom with 1:1 slopes. The concrete lining was 6 in. thick. Below the headworks for 250 ft. was a combination wood and concrete flume 38 ft. wide and 12 ft. deep. The floor was a 6-in. concrete slab. The side-walls were of 2-in. plank with 12 by 12-in. posts spaced 3 ft. centre to centre. The walls were tied together with 1-in. iron rods spaced 7 ft. 6 in. centre to centre at the base and 15 ft. at the top. The walls were supported against back-pressure with 1-in. rods and dead-men every 15 ft. and concrete counter-forts every 45 ft. This concrete and timber lining was designed to carry the water past the core-wall of the main dam. This temporary spillway has since been removed, as the main dam will be high enough by the time next winter's floods come to handle any discharge. The run-off during the season of 1917-18 was so small that this spillway was never used. The plans for the dam when completed provide for an additional spillway of open-flume construction through a saddle adjoining the north-east abutment of the dam. The total spillway capacity will be 14,000 second-feet.

To provide water for hydraulic operations, a diversion-dam as shown in Fig. 1 and 2 has been constructed. The crest-length is 720 ft., the maximum height, 50 ft., the maximum width, 300 ft., and the quantity of material 126,831 cu. yd. The toes of the dam were constructed with rock excavated by steam-shovels and hauled to the dam in wagons, motor trucks, and dump-cars. About 20% of the clay in the central core was sluiced from a borrow-pit at an elevation of 315, using a 20-in. flume on a 5% grade. The remaining 80% was obtained by washing the clay from the material lumped in the toes toward the centre of the dam. The diversion-dam was commenced January 17 and completed July 3, 1917.

Work on the main dam is now under way. The material for the toes is excavated by steam-shovels from borrow-pits in the side-hill on the north side of the dam and is hauled in wagons. Several pits for the hydraulic fill have been opened. About 12 second-feet of water is used in the sluicing operations and from 6 to 9% suspension is generally obtained. Most of the pits are situated so that the average distance for sluicing is 500 ft. Up to May 1, 291,481 cu. yd. of material had been placed in the dam.

The tunnel that is to serve Oakland and the other bay cities except Richmond has its intake about 1½ miles upstream from the dam. The invert of the tunnel at the intake is about 60 ft. higher than the bed of the stream at the dam. The tunnel has a horshoe section 6 ft. 6 in. high and 5 ft. 6 in. wide. The total length is 13,563 ft.



HEADING OF WASTEWAY TUNNEL

and the grade is 1 in 1000. The elevation of the summit of the ridge pierced by the tunnel is about 900 ft. higher than the grade of the tunnel.

The tunnel is being driven from four headings, one at each end and two from a shaft in Wildcat canyon. Work was commenced in August 1917 at both the end-headings and at the shaft. The progress in the headings varies from 10 to 20 ft. per day, two shifts being worked. The Wildcat canyon shaft is 295 ft. deep, 180 ft. of this shaft was sunk through adobe clay in 45 days and the remaining 115 ft. through shale was constructed in 30 days. The total amount of tunnel driven from all four

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headings to May 1 was 10,056 lin. ft., leaving 3507 lin. ft. still to go, and indicating that the driving of the tunnel will be finished during this summer. The principal materials encountered after passing through some clay, sand, and boulders near the portals include sandstone, schist, serpentine, shale, and sandy shale. Some thin streaks of a fair grade of coal have been found. When the tunnel is completed, the Wildcat Canyon shaft will serve to divert the flow of Wildcat creek into the tunnel. About half the tunnel will be lined with concrete and the other half unlined. The work of lining has been commenced. A rapid sand-filtration plant having a capacity of 21,000,000 gal. per day will be constructed at the Berkeley portal. The filters will be built in batteries having a capacity of 3,000,000 gal. per day.

The drainage-area of the reservoir is 31.25 square miles. The capacity of the reservoir is 42,000 acre-feet or approximately 14,000,000,000 gal. The safe yield from the reservoir, operated independently, is 13,200,000 gal. per day. Operated in conjunction with the other reservoirs of the company's system, the safe yield from the reservoir is 17,100,000 gal. per day. The storage capacity below the intake of the Berkeley tunnel, which is therefore available for the city of Richmond only, is 536,000,000 gal., and the safe yield from this part of the reservoir-storage is 1,470,000 gal. per day. The total estimated cost of the project is $2,300,000, making the cost per million gallons per day for unregulated draft, $175,000, and for regulated draft in conjunction with other reservoirs, $134,000. The work is being done under the general direction of G. H. Wilhelm, general manager for the East Bay Water Co. George Hawley is resident engineer in charge of the work. Bates & Borland, of Oakland, are the contractors.

MAINTENANCE OF EARTH ROADS*

By JOHN H. MULLEN

To maintain traffic efficiently over a highway it is necessary, first, that no water stand on the roadway or in the side-ditches or gutters, and that defects in the surface be repaired or improved by the addition of such material as may be required to form a crust which will maintain the loads and resist wear; second, to follow with dragging and planing. The general repairs and minor improvements should be made in the early spring and late fall by special crews, which may be assigned to necessary construction during the time they cannot be employed economically on maintenance. The shaping or re-shaping of roadway and cleaning of ditches can best be accomplished by a blade-grader. This is the most efficient implement for general maintenance. It can be hauled to best advantage by a tractor. The general repairs must, of course, be done by men and teams, but the dragging and planning is developing into a tractor proposition. The unwillingness of farmers to use their teams on this work at the time they are needed is forcing the use of light tractor outfits which can care for four or five times as much road as teams. The use of re-built Ford machines is becoming quite general, especially the convertible attachments which allow the machine to be used as a runabout when not employed on dragging. Many of our maintenance men have such machines which can be converted in about half an hour. Such equipment gives more attractive employment, permits dragging-sections six to ten miles long instead of the usual one to two miles, and permits continuous work during hot weather or when flies annoy teams. Dragging has also been done in this way at night, which is not feasible with teams. The cost of tractor-dragging is, all things considered, about the same as team-work, but it is more efficient and reliable. As a general thing two planers are hauled at one time with a tractor.

*From paper read at a meeting of the Association of State Highway Officials, Richmond, Virginia.

Electric heating for the boilers of steam locomotives has been proposed on the Swiss railroads on account of the high cost of coal. The plan is still in the discussion stage, but the advocates of electric heating claim that it can compete with coal, assuming the cost of coal to be $20 per ton and the cost of electric energy to be $0.003 per kw-hr. The principal question is the amount of heating-surface required with electric heating, the opponents of the plan claiming that the heating-surface would have to be increased about 250%, which would require such an addition to the weight of the locomotive as to be prohibitive.

Consumption of portland cement in the United States during 1916 was 92,179,242 bbl. or 0.89 bbl. per capita, as compared with 0.83 bbl. in 1915. The highest per capita consumption was 1.77 bbl. in Iowa and the lowest, 0.13 bbl. in Mississippi. The per capita consumption in the Western States, in barrels, was as follows: Arizona, 1.40; California, 1.51; Idaho, 1.01; Montana, 1.44; Nevada, 0.49; Oregon, 0.63; Utah, 1.34; and Washington, 1.32. The production of natural cement, which reached its height in 1899 with nearly 10,000,000 bbl. per year, is now less than 1,000,000 bbl. per year.

Coal gas as a substitute for gasoline is being used extensively in Great Britain. Since the Government does not permit the use of steel cylinders, the rubber-tire manufacturers have constructed a container of rubber and fabric. These containers are about 4 ft. 6 in. long by 1 ft. 3 in. diam. They weigh about 60 lb. and hold the equivalent of 2 gal. of gasoline. One gallon of gasoline is the equivalent of 250 ft. of coal-gas, but as coal-gas costs 60 to 80c. per 1000 cu. ft. and gasoline costs $0.84 per gallon, the saving is considerable.

The average freight-car load on the Southern Pacific Co. lines during the three months ended March 31, 1918, was 26.89 tons. The average load for the corresponding period in 1917 was 23.29 tons. The amount of freight handled increased from 4,412,050 tons in 1917 to 4,749,815 tons in 1918, while the number of cars required decreased from 189,432 to 176,631.

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DAYLIGHT SAVING*

By SAMUEL INSULL†

I have been active in trying to get daylight-saving legislation passed. But, instead of its being in effect for five months or seven months, I wanted it for the whole year. On January 4 I telegraphed T. W. Sims, Chairman of the Committee on Interstate and Foreign Commerce of the House of Representatives as follows:

"If daylight saving is made effective throughout the year, day power-load and evening lighting-load will not overlap to as great an extent as at present; thus avoiding sharp peak in load and thereby releasing plant investment for other purposes and making further saving in coal; otherwise necessary to fire up additional boilers to cover this peak for short time in winter months."

In February, thinking I might possibly be able to arouse a general interest in this subject, I addressed a letter to the managing editor of the Chicago 'Daily News' in which I stated:

"So far as the electric industry of the nation is concerned, the situation is simply this: The passage of the bill in its present form would result in the saving of coal to the electric companies and in a saving to their customers in electricity consumed; but the electric companies would lose a large amount of revenue, which the saving of coal would not offset. On the other hand, if the change of time were made effective throughout the year, consumers of electricity would enjoy further saving in electricity consumed, while the electric companies would be distinctly benefited because their day power-load and their evening lighting-load in the winter months would not overlap as they do now and the companies would not be forced to maintain the equipment necessary to carry them through the period when the loads so overlapped.

"There is another important benefit that would be gained by a change in time throughout the year, which is lost entirely if the change is made for the summer months only. In many districts, especially in the towns where the manufacture of munitions is extensive, the electric companies have been finding their capacity in the winter months inadequate to supply the demands upon them during the period of the day when their power and light loads coincided and, consequently, have been forced to cut off power customers, often to the detriment of the munitions business. This situation would be greatly relieved if the clock could be moved forward one hour during the winter months, and the nation, in its present crisis, would be distinctly benefited."

However, my appeals on that subject and the appeals of some of my friends did not have any effect, and we have a seven-months' daylight scheme. It follows to a large extent the procedure taken by England, France, Italy, and Germany as a war measure, although the subject has been discussed in England since 1908.

The seven-months' daylight schedule means a saving of 300,000 tons of coal. The chances are that the all-the-year-round daylight schedule would not save much more coal, probably not more than 125,000 tons more. The loss of income is over $9,500,000 and the saving in fuel is about $900,000. The net loss to the companies is about $8,600,000. Now, if that scheme were run the whole year, over 400,000 kw. of capacity would be released. Between $150,000,000 and $200,000,000 of capital now employed would be released because the 400,000 kw. released by a change in the winter-peak could be sold for supplying energy to necessary industries. The saving in the fixed charge, if a large amount of additional business could be taken without increased capital investment, would be from $8,000,000 to $10,000,000.

Such a scheme would conserve between $150,000,000 and $200,000,000 and would place immediately at the disposal of the Government 400,000 kw. of capacity that cannot be supplied at this time in any other way.

*Extract from address delivered at San Francisco before the Electrical Development League.

†President Commonwealth Edison Co., Chicago.

The tallest chimney in the world, at Sagonoseki, Japan, is made of concrete. It is 570 ft. tall, and is on a hill 430 ft. high. The inside diameter is 26¼ ft. at the top and 42 ft. at the base. The foundation is 95 ft. diam. and contains 2700 cu. yd. of concrete. For 150 ft. the chimney is reinforced by a concrete lining, separated from the outer concrete shell by a 5-ft. air-space. In the construction of the chimney 400 tons of steel was used. The next highest chimney is in Montana, 506 ft. Others are as follows: At Port Dundas, Scotland, 488 ft.; Glasgow, Scotland, 454 ft.; Freiburg, Saxony, 453 ft., on hill 259 ft.; Mechernich Lead Mining Co., 440½ ft.; Tennant & Co., Glasgow, Scotland, 434 ft.; Halifax, England, 381 ft.; Metropolitan Street Railway Co., New York, 353 ft.; Omaha & Grand Smelting Works, Denver, Colo., 350 ft.; Fall River Iron Co., 350 ft.—'Mechanical World.'

A diamond-drill hole in Sussex county, New Jersey, 4920 ft. deep, has recently been completed by the contract drilling forces of the Sullivan Machinery Co. A 2-in. diameter core was removed to a depth of 1600 ft., beyond which tools removing a 1⅜-in. core were used to the completion of the hole. When the depth of 4900 ft. was reached, the long line of rods required for drilling weighed 13 tons, and it took 8 hours' steady work for hoisting them out, replacing them, and resuming drilling.—'Mechanical World.'

Two metal-planing machines, the principal parts of which will be of monolithic reinforced concrete construction, are being built by the Amalgamated Machinery Corporation, Chicago. The work of the machines is the planing of beds for long gun-boring machines. The concrete beds of the planes are 184 ft. in length; the platens are 90 ft. long and 13 in. thick. The width between housings is 72 in., and the cross-rail which is stationary and faced with cast-iron, is 4 ft. square.

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Commercial Aspects of the Shale-Oil Industry

By J. H. G. WOLF

The possible development of the shale-oil industry in western America as a means of augmenting the crude-oil supply is attracting much attention. The timeliness of the subject is undeniable because of the ever-widening demand, both for purposes of war and of peace, and because of the apparent inability of the oilfields of the United States to fully meet the increased need of petroleum products. Preliminary estimates show that this country consumed (inclusive of its export trade) 390,000,000 bbl. of crude oil in 1917, but produced only 335,000,000 bbl. The deficiency of 55,000,000 bbl. was met by drawing 20,000,000 bbl. from stocks and by importing 35,000,000 bbl. from Mexico.

The second reason for the manifest interest in oil-shale lies in the accredited existence of enormous reserves of such shale areas in the Western States, having a higher average oil content than the shale treated for oil abroad. Having the two conditions necessary for the development of an industry satisfied, namely, the fixed demand for its products, and the abundance of the raw material with which to operate, we may look forward with confidence to early developments of importance. Competition with natural crude oil would be impossible if the oil were the only product from the shale; at least that is true at the present prices. A market must be developed also for the ammonium sulphate that can be produced as a by-product in the distillation of the shale.

During the recent hearings at Washington before the Public Lands Committee of the House, on the pending Mineral Lands Leasing Bills (S. 2812 and H. R. 3232), which measures are to open, on the leasing principle, the remaining oil, coal, and phosphate areas on the public lands of the United States, delegates appeared from Utah, Wyoming, and Colorado, urging the necessity for considering, at the same time, the shale-oil problem, as there is now no specific law for acquiring title to these particular lands. Rights to shale land are being initiated under the placer-mining laws. Having in mind the unhappy experiences of the oil-land operators with this inept and archaic law, it is natural that those fostering the new industry should fear a repetition of the experience of the oil men with that statute.

It is necessary, also, to sound an alarm of another character. Among those who appeared for the oil-shales at the aforesaid hearings was one public official, Russell D. George, the State geologist of Colorado, whose testimony seems worthy of more than passing notice. Mr. George gave, on February 26, the benefit of 10 years' study and observation of the shale-oil industry and its possible development in the Western States. With true scientific and economic interest in the subject he fearlessly asserted that, regardless of promoters' claims, the only possible hope for commercial success lay in conducting operations on deposits yielding not less than 50 gallons of oil per ton of shale, and that these must be upon the very largest scale, with capital in ample volume, and with technical skill of the highest order. The crux of his testimony was that no operations of less than 1000 tons capacity per day, conducted under the best physical conditions, could hope to succeed at present, and that such operations would require an initial capital expenditure amounting to upward of $2500 per ton per day capacity, or $2,500,000 for a completed and running plant. That figure did not include a sulphuric-acid manufacturing plant for the refinery, which might add $300,000 to the sum, but it did presumably include the cost of opening a deposit of shale for mining operations upon the scale stated. The figures of Mr. George were corroborated by Arthur L. Pearse, an oil-shale technologist, who followed, and who spoke from 40 years experience abroad. The importance of such testimony may be realized when it is considered that oil-shale enterprises are being proposed, and some are reported actually under construction, planned for such limited capacities as 100 tons per day, and with a capital equipment of only $75,000 to $100,000 each. These, as pilot plants, will serve a beneficial purpose. Unless Mr. George views the situation and the requirements from too conservative a standpoint, there surely will be some financial and industrial wrecks on the highways of Colorado. Evidence was offered at the hearings, by a committee of the Utah section of the American Mining Congress, proposing cost estimates of $750 to $1000 per ton per day capacity as a basis for capital requirements, but unfortunately no minimum-quantity capacity-figures were included in the estimates. As substantiating the higher figures of Mr. George, the history of the Scotch shale operations offers an illuminating commentary. The works in Scotland reduce about 3,500,000 tons of shale annually, this being the output of six major plants. The industry was already established there when Drake drilled his first oil-well in Pennsylvania in 1859. In the 'seventies, as many as 50 different companies conducted the operations, which treated but 1,000,000 tons of shale annually, or about 60 tons each per diem. Today these 50 plants have been reduced (or consolidated) to a half dozen, while the output has been more than trebled, each plant treating 2000 tons per day. The margin of profit, even on that scale, is admittedly small. The Scotch shale is leaner than that of western America, but the operators abroad have the advantage of cheaper labor, and a larger by-product resources, that is, more ammonium sulphate, in addition to an exclusive oil market, because Great Britain has no natural oil deposits now known; and the market, moreover, is in the midst of a densely populated country. It is plain, therefore, that the capital expendi-

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ture for a shale-oil plant must be on a scale not unlike that on which the 'porphyry' coppers of the West are conducted; the history of the Scottish industry, if correctly interpreted, confirms this fact unmistakably.

A further analysis, even superficially made and considered, of the elements that control oil operations on any basis gives warning to all who would venture hastily and insufficiently equipped within its province. It is a relatively easy thing merely to produce crude oil, a venture requiring only the wise selection of the right ground and enough capital to sink wells, because the bigger factor, the marketer and the refiner, will install the necessary pipe-lines and pump away the product. The producer's responsibility ends when he has got the oil on the surface. One hundred thousand dollars judiciously spent can frequently launch an oil venture in an average field. It is quite another thing, however, to be properly established in the oil business, which comprehends not only the simple matter of producing the crude staple, but the all-embracing enterprise of piping, refining, and marketing the finished products, wherein lie the bigger profits. Those who market as well as produce oil in California are capitalized as high as $15,000,000 to $100,000,000 each. While there are 300 oil-producers there are fewer than a half-dozen marketers. From the evidence obtainable it is apparent that to engage successfully in the shale-oil business the enterprise must consist not only in mining the raw material, but also in treating it by distillation, with a plant equipped to produce the oil and the ammonium sulphate, after which the crude oil must be refined and fractionated for its marketable products. Even then, without some marketing and distributing organization, including the many capital demands that it entails, an enterprise can fall just short of being a commercial success. Thus it appears that, to become properly established in the shale-oil business, the enterprise must have very nearly the same equipment as a natural-petroleum marketer, rather than that of a mere oil producer. Upon that premise the estimate that it will take $2,500,000 adequately to launch a single unit in the business is not unreasonable.

Other observations in the testimony of Mr. George are worthy of careful consideration by those interested. The main points are as follows:

1. It requires a ton of water, in the manifold operations, to completely treat a ton of shale, and the shale deposits of western Colorado, southern Wyoming, and eastern Utah, embracing about 16,000 square miles of supposedly workable deposits, lie mainly at an elevation of 8000 ft. above the sea, where water is relatively scarce, and in a region famed for its aridity. The water-rights to the principal streams have, in a general way, long since been pre-empted. Engineering problems as well as technical problems of great magnitude doubtless face each new enterprise.

2. An oil-shale is not a mere container of residual oil; the shale is the depository of the remains of plant and animal life which, when distilled, yield hydro-carbons that associate in a form that make crude petroleum. Crude oil, as such, therefore does not exist in the raw shale; it is produced upon the application of heat to the shale.

3. The shale deposits can be mined exactly as coal, where the overburden does not permit of stripping and working with the steam-shovel. Coal is produced in Colorado at a total working cost of $1.18 per ton at the pit-mouth, and shale mining, though dealing with a tougher substance, should cost no more. The capital investment to open an ordinary coal mine amounts to 77c. per ton per year capacity; that of an oil-shale enterprise $7.50 per ton per year, and no operations should be undertaken on less than 6000 to 7000 acres, or, say, 10 square miles of deposits. This means that it will require 40 association placer claims of 160 acres each to satisfy the requirements as to acreage for one complete enterprise.

4. There should be obtained, on an average, from the richer shale worked at the outset (that is, the 50-gallon per ton shale) an extraction of 85% of the oil, namely, of the oil-making or kerogen content, and 60% of the 41 lb. of ammonium sulphate theoretically available. Many new processes of extraction have been proposed, which are being tried in the laboratory and on a small-sized working-scale, but the obvious procedure in designing the reduction plant is to follow closely the technology as developed in Scotland and France; not that no room exists for improvement in the foreign practice, but that no new principles have been developed among the foreign operators in a generation. The improvements made have related to the modes of practice. The Scottish plants consume from 80 to 200 lb. of coal per ton of shale treated, while in America the combustible gases, which issue on retorting the shale, should, it is stated, supply the needed fuel. Owing to the greater thickness of our deposits, an acre of western American shale land is alleged to contain ten times the amount of extractable oil yielded by an acre of Scottish shale.

Upon the conclusion of Mr. George's testimony, Mr. Pearse added, in substance, that the shale-oil industry is a more highly developed and a livlier one in France than in Scotland; that Spain and Brazil are getting busy with the industry, as are also Australia and other countries. He asserted that, if it had not been for the developed industry in France, the Allies would have been seriously handicapped for toluol and other compounds needed for making high explosives; that the grade of oil obtained in reducing the shale was determined entirely by the manipulation, as the main trouble in retorting lay in the carbonization of the material, which prevents the heat from penetrating the charge; that there are practically no commercial by-products save the available ammonium sulphate, and that the ash, after being drawn from the retort, consists of absolutely nothing but plain clay and sand, and offers but little chance of recovering potash commercially as had been alleged by some. Finally he said that the capital required for operation on an adequate scale is enormous, and that the facilities and the technical skill must be provided on a commensurate scale.

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Material Survey an Essential for Economic Highway Construction*

By H. S. MATTIMORE†

With the object of determining the natural materials suitable for highway building, the New York State Highway Commission has had under way for several years a material-survey of the parts of the State where road improvement is contemplated. This survey is an outgrowth of the former haphazard methods of sampling material along a proposed highway route at some time previous to the actual letting of the contract for improvement. This latter method, without any real scheme of organization, revealed many weaknesses. Sources of materials were used which were not economical in either quality or first cost. Frequently the data obtained were insufficient. This not only misled the designing engineer but also the contractor estimating the work.

Rgardless of how well the other preliminary work is carried on, inadequate information regarding materials will lead either to extravagant or unfair estimates and as a consequence cause either unnecessarily costly construction or else avoidable litigation. It has been found in New York that when full information is furnished to prospective bidders for highway improvement the prices are not only fairer but the work attracts a more reliable class of contractors.

The successful accomplishment of a thorough material-survey requires a knowledge of highway engineering, with enough knowledge of geology for the identification of the more common rocks and their position in the geologic scale. The first step in this work is a reconnaissance of the territory adjacent to the proposed improvement. A record is made of the most favorably situated material deposits. The engineer employed on this work must have had sufficient highway experience to enable him to judge when deposits are practical to work and which are the most economical to use. After these deposits are determined the most favorable ones are investigated in some detail so that the extent and quality of the material can be reported upon. Rock ledges are blasted so that unweathered samples can be obtained and tested. This latter precaution is especially advisable in limestone and sandstone deposits. If detached stones in fields or fences are available and considered the most economical source of material, a fairly accurate estimate of their extent and position is taken so that hauls can be computed. The most difficult problem in investigating field-stones is securing representative samples for test and estimating proportions of the different qualities available.

Investigation of sand and gravel deposits is difficult. Few, if any, sand and gravel deposits are uniform. The investigator often has trouble in deciding how practical it is to work the various deposits that have been found. Some skill and experience is necessary in order to secure an approximately representative sample. Occasionally many test-pits are required to determine the amount of material available.

The amount of time and expense necessary for investigation of individual projects is likely to vary with each project. If the situation is such that materials from commercial sources would be costly because of long hauls, a greater expenditure of time and expense is justified in seeking for local materials, than when commercial supplies can be obtained at low cost.

The situation of materials sampled and tested is recorded upon topographic maps and filed for reference. Sand is represented by triangles and stone by crosses. The test number under which detail data are filed is also shown on the map. Following the number in the case of stone deposits there is a letter, which is an abbreviation of the stone classification; as 'S' for sandstone, 'D' for dolomite, etc. Following this letter is a figure called the weighted value. This is computed by giving relative weights of three, two, and one to the abrasion, hardness, and toughness tests. The test-results are multiplied by these weights and the products added for the weighted value. The convenience of having the one figure for the comparison of rock-tests can readily be seen.

For sand or gravel, the letter 'S' signifies that the deposit is a suitable supply for sand only. If the letter 'G' is used it indicates that the supply contains both sand and gravel. A number following the letter shows the quality of sand, No. 1 being the highest grade. The letter 'W' following this number indicates that the material must be washed before using.

The maps containing these general material-data are bound in book-form. Detailed information, with tests, sketches, or photographs of the various deposits, is also kept on file.

*Abstract from 'Concrete Highway Magazine.'

†Engineer in charge of Physical Testing, New York State Highway Department.

Removal of old gaskets by sawing is convenient when a leaky gasket is found in a flange-joint pipe-line and the pipes are so restrained that the flanges cannot be pried apart. After the bolts have been taken out the gasket can be cut with a saw, preferably one that has been discarded as a regular tool. It is essential that the adjacent faces of the flanges be clean before the new gasket is inserted, otherwise the joint is likely to leak. If possible, the flanges should be forced apart, so they can be scraped with a chisel. If this cannot be done the saw can be used for a scraping tool.—T. W. Martin in 'National Engineer.'

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Reinforced Concrete Highways

By W. B. SAWYER, Jr.*

The rapid change that has taken place in the traffic upon our highways in the last few years has had a marked effect upon standards of construction. Only a few years ago the macadam road represented the best type known, but with the increase in the number of motor-driven vehicles, defects developed, demonstrating that this material could not withstand the burdens imposed. The heavy loads carried at high speeds produced crushing forces far in excess of the strength of the binder. To meet these new conditions of traffic, a material of greater strength was necessary. So far the only material that has been found adequate is portland cement concrete. When properly mixed and placed concrete makes an ideal pavement. Since 1910 many thousand miles of concrete highways have been built. With this rapid development of the concrete road some defects have appeared, but these are now being satisfactorily remedied. The most serious defect has been

FIG. 1. METHOD OF PLACING STEEL-WIRE REINFORCEMENT

the tendency to crack, which is a familiar characteristic of the plain-concrete road-slab. Before describing the methods used to prevent or to control this tendency it may be of interest to discuss briefly the underlying causes of cracking.

Transverse Cracks

1. Expansion of concrete because of change of temperature. The coefficient of expansion of concrete is 0.0000055 per degree F. For every degree F. rise in temperature, concrete will expand 0.0000055 times its length. If the concrete slab were resting on a frictionless plane this movement would cause no stresses in the slab, but unfortunately we do not have any such ideal conditions. There is a definite amount of friction between the surface of the sub-base and the surface of the concrete slab above it. This varies with the kind of base and the degree of roughness of surface. The friction between the two surfaces resists any movement. When movement does occur, the resistance of friction causes tensile stresses in the concrete. When these stresses become greater than the tensile strength of the concrete, cracks occur.

2. Change in Moisture-Content. Another cause of cracking and probably the most important one is change in the moisture-content of the concrete. When concrete is hardened under water or under moist conditions it expands slightly. The expansion varies somewhat with

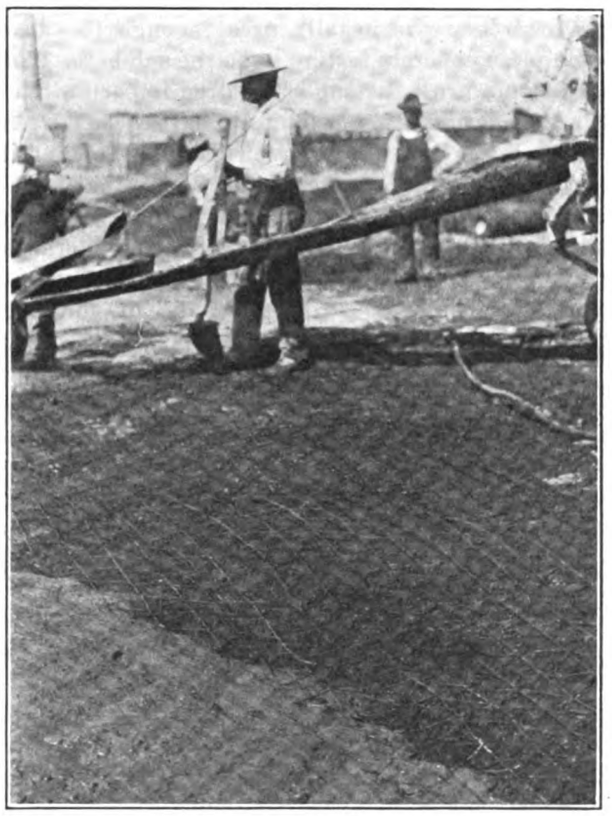

FIG. 2. CONCRETE BEING POURED OVER WIRE FABRIC

different mixtures and according to tests is from 0.02 to 0.05% of the length. When concrete is hardened in air and the moisture is evaporated, it will contract. The shrinkage may be as much as 0.08% of its length. To counteract this contraction by an equal amount of expansion, because of a change in temperature, a rise of 145° F. would have to take place. This is illustrated by the recent statement of the United States Bureau of Standards that concrete roads expand in winter and contract in summer, because of increase or decrease in the moisture-content. This shrinkage, caused by the drying of the concrete, occurs when the concrete is not

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fully hardened and its tensile strength is low, probably not over 50 lb. per square inch; therefore the stresses developed by only a slight movement of the slab at this time will produce cracks. These are the characteristic transverse cracks which occur in plain concrete pavement at intervals of 25 to 35 feet.

Causes of Longitudinal Cracks

1. Non-uniform Bearing on Sub-base. This may be the result of unequal settlement of fill or similar causes. The road-slab is not designed to carry its load as an ordinary floor-slab or beam. If the slab is left unsupported, either at the centre or sides, the load imposed will often cause longitudinal cracks.

2. Expansion or Contraction of Sub-base Because of a Change in Moisture-Content. The most troublesome sub-base in this regard is the adobe of central and southern California. This soil absorbs water, causing considerable expansion, then upon drying shrinkage takes place and opens the familiar adobe-cracks. The shrinkage-stresses are usually great enough to cause cracks in plain concrete resting upon the sub-base. The supporting power of the sub-base is the important element in the consideration of longitudinal cracks. Even with the most careful construction methods it is hard to get a uniform and homogeneous sub-base that is dependable as far as supporting power is concerned.

Consideration of the various causes producing cracks in unreinforced concrete shows that the most important and most frequent are, first, shrinkage of concrete when hardening, causing transverse cracks, and, second, insufficient support of sub-base, causing longitudinal cracks. By increasing the tensile strength of the concrete slab it has been found that these cracks can be either entirely eliminated or else so controlled that they are no longer a serious defect. This increased tensile strength is gained by the addition of steel reinforcement.

Two systems for placing the reinforcement are now being used in California with success. The first system is for eliminating the longitudinal cracks. The steel is in the form of wire fabric in strips about 5 ft. in width and in length equal to the width of the road to be paved. The main or longitudinal wires are placed at right angles to the centre-line of the road. The weight of fabric varies from 22 to 35 lb. per 100 sq. ft., the average being about 31 lb. The method used in placing the fabric is simple and has been found not to hinder or retard the mixing and placing of the concrete. The fabric is placed on the job in proper lengths. These strips are placed one at a time upon the prepared sub-base directly behind the mixer, between it and the already finished pavement. The concrete is then poured in the usual manner and allowed to flow over the mesh. After the shovel-men have properly distributed the wet concrete to the required thickness, a small hook is used to raise the wires to the centre of the slab. Care is taken to make sure that the steel is embedded approximately in the centre, as, of course, it would be useless if left resting upon the sub-base. Two extra men per gang are needed for handling and placing the fabric. Fig. 1 and 2 show the fabric in place and the concrete being poured. The photographs were taken at Redwood City in 1915. This method of reinforcing has proved satisfactory. It eliminates the longitudinal cracks. Fig. 4 shows a 4-in. plain concrete slab, mixture 1:2:4½, with expansion joints placed every 10 ft., exhibiting the characteristic longitudinal cracks caused by settlement of sub-base. Fig. 3 shows part of the road adjoining that in Fig. 4. This slab is 4 in. thick, reinforced with light wire mesh, mixture 1:2:4, expansion joints every 9½ ft. There are no cracks in this section showing that a small amount of steel is sufficient to prevent the longitudinal cracks that formed in the other pavement.

This system of reinforcing has been used extensively by the State Highway Commission of California. They have found it especially useful in preventing longitudinal cracks in pavement that is laid over adobe sub-base. Fig. 6 shows part of the State Highway near Newbury Park, Ventura county. This was built during 1917. Bad conditions of adobe soil were found. The particular section shown here is a 6-in. slab unreinforced. The characteristic longitudinal cracks are clearly seen. Fig. 5 is the adjacent section of the same thickness, but reinforced with wire mesh. No cracks have appeared in this section, although it was under water a part of last winter.

The second system for placing the mesh is designed to control the transverse cracks in the concrete and to increase the distance between them. Some highway engineers control these transverse cracks by placing contraction-joints every 25 to 35 ft. Such joints are the weakest feature of the concrete pavement. No matter what type of joint is used they must be given frequent and careful attention to prevent rapid deterioration of the adjacent pavement. They should therefore be separated as far as possible. This is accomplished by placing the main or longitudinal wires of the reinforcing material parallel to the centre line of the road. The method employed is similar to the first system described, with this difference—the mesh is not cut into strips, but is placed on the job in rolls several hundred feet long and of the proper width. These rolls are placed directly behind the mixer. They are unrolled as the mixer is moved forward, thus making the longitudinal reinforcement continuous. The concrete is poured and the steel is raised by hooks to the centre of the slab as in the other system. Two or three rolls are used, depending on the width of the road. By giving a small lap on each width, reinforcement at right angles to the direction of the road is obtained. This prevents the longitudinal as well as the transverse cracks. The advantages of this system are obvious. It eliminates many expansion joints, prevents longitudinal cracks, and is somewhat cheaper than the first system. This system has been used with great success in Tulare county under the direction of Byron Lovelace, county highway engineer. One stretch of road in particular is worthy of mention. In building the main highway near

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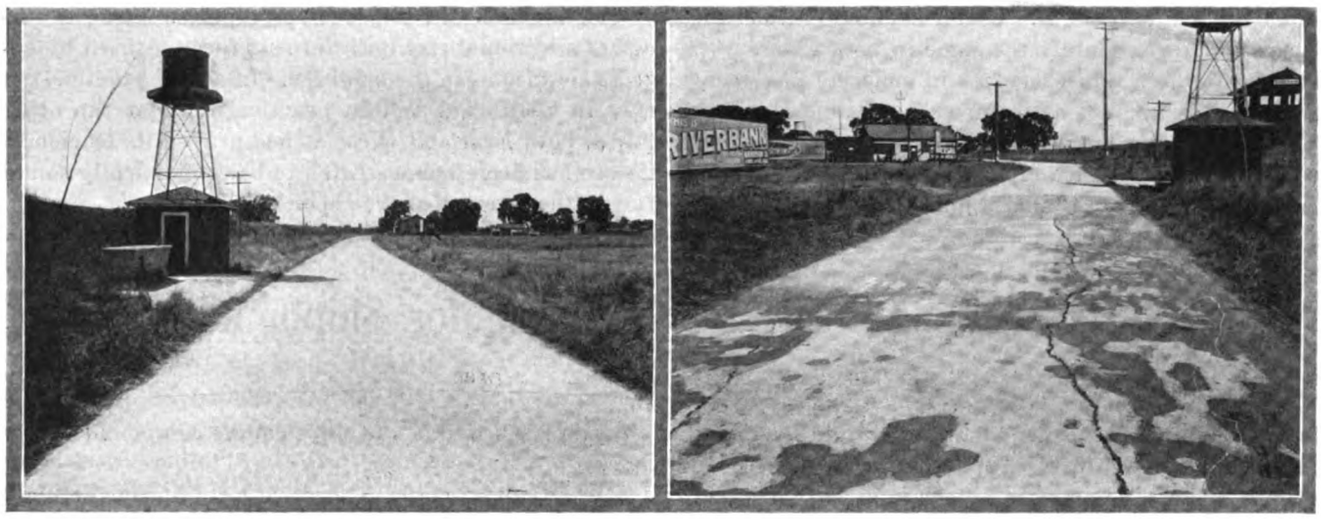

FIG. 3 AND 4. REINFORCED AND PLAIN CONCRETE PAVEMENT AT RIVERBANK, YOLO COUNTY, SHOWING CRACKS IN PLAIN CONCRETE

Exeter a great deal of adobe soil was found in the subbase. It was therefore decided to reinforce the entire section. The system described above was used. Although the contraction-joints were placed about 600 ft. apart, not a single crack can be found in the mile of highway. Experience with this system of reinforcing has shown that the distance between contraction-joints can be made as much as 300 ft. with safety, thus allowing joints to be placed at midday and at the end of a day's run, where the daily run is about 600 linear feet.

The cost of the reinforcement varies, of course, with the situation of the work and the weight of reinforcement. Basing costs on contract work in central California and with steel weighing about 30 lb. per 100 sq. ft. of mesh, the cost of the material delivered is approximately $1.65 per 100 sq. ft. Adding to this $0.10 per 100 sq. ft. for hauling and placing, gives a total cost of $1.75 per 100 sq. ft. for reinforcement in place. The cost per mile for reinforcing a road 15 ft. wide is $1386. The annual interest charge, therefore, per mile is about $70. This annual cost is much less than the cost of maintenance and repair because of the cracks in plain concrete pavement, and is also largely offset by the elimination of the first cost of nearly all of the contraction-joints. A light slab properly reinforced will outlast a heavier slab without reinforcement. Although the slab should be heavy enough to carry the traffic safely, in cases where first cost is of primary importance, better results can be obtained by using a relatively thin slab with proper reinforcement than a slab

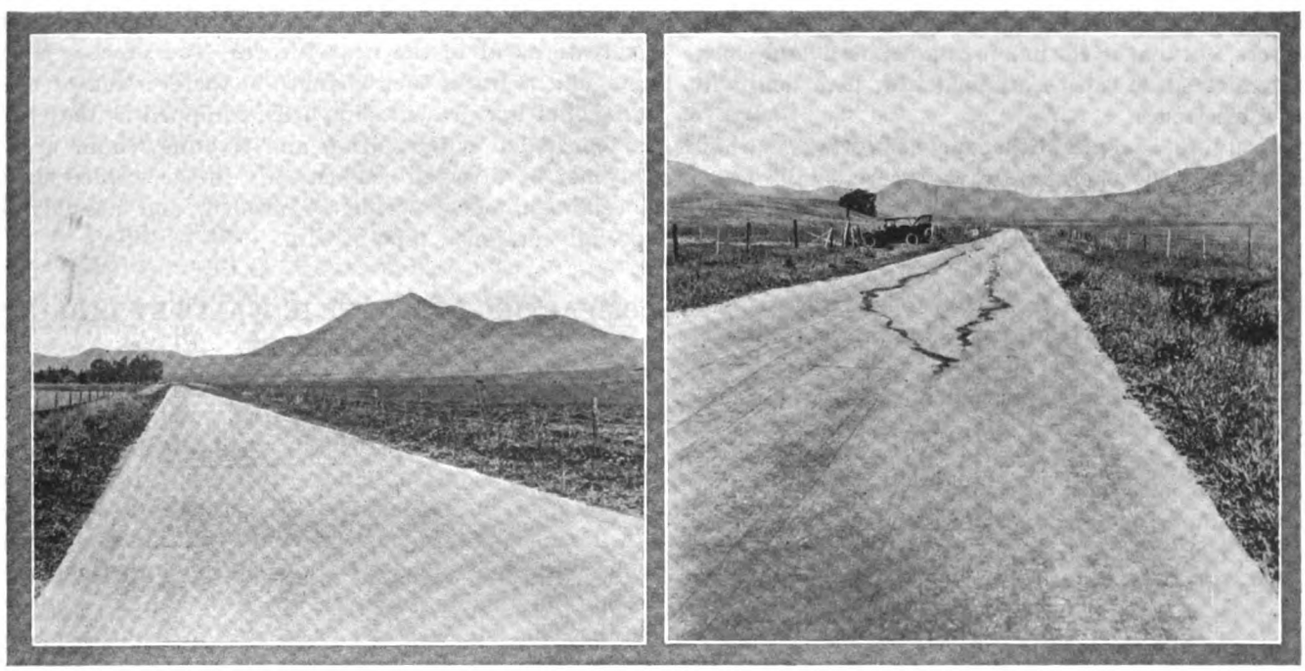

FIG. 5 AND 6. REINFORCED AND PLAIN CONCRETE PAVEMENT AT NEWBURY PARK, VENTURA COUNTY, SHOWING CRACKS IN PLAIN CONCRETE. PHOTOGRAPHS TAKEN AT STATIONS 0 AND 30

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an inch thicker without it. Under such conditions the first cost is approximately the same in both cases.

The use of steel reinforcement in concrete pavement is theoretically correct as it furnishes tensile strength to the concrete and enables it to resist stresses that would otherwise produce cracks and which, even with an asphalt top, either reduce the life of the pavement or else increase the expense for repairs. Also, it furnishes additional strength to resist forces caused by adverse conditions in the sub-base. In actual practice, not only in California, but in practically all of the other States both East and West, it has proved its efficiency. Its use has been demonstrated to be economically sound and in the interest of true economy.

Electric Welding Instead of Riveting for Shipbuilding*

There are two processes of electric welding, spot-welding and arc-welding. Spot-welding is similar to riveting. Instead of punching holes in steel plates and fastening them with rivets, the two electrodes are applied at opposite sides of the plates to be joined. The current is turned on and the plates act as a resistance. The metal at one spot with about the same diameter as a rivet is fused in a few seconds. A pressure of 24,000 lb. per square inch is then applied. Plates joined in this way have been tested to destruction, and failure usually occurs in the plates themselves, not in the joint. The electrodes used are of the same metal as the plates to be joined. Some material is melted from the electrodes during the welding and finds its way to the joint.

Two forms of electrodes are used, the bare and the covered. On account of the high temperature, oxygen is likely to be mixed with the fused metal when the bare electrode is used, causing bubbles and weakness in the joint. In England to overcome this difficulty, the electrodes are coated with some material that prevents the access of oxygen. The general opinion in the United States is that covering the electrodes permits spot-welding to be done successfully by less experienced operators, but that in the hands of an experienced workman greater speed can be attained with bare than with covered electrodes.

Arc-welding is done with copper electrodes, which do not fuse. The operator draws them steadily along the edges of the plates to be joined, forming a continuous seam. The metal at the edges of plates is melted almost immediately, some of it even being vaporized. The whole process takes from 10 to 20 seconds. If spot welding is similar to riveting, arc welding is similar to calking.

A standard bulkhead-door was recently constructed at the New York Shipbuilding Corporation yard at Camden, New Jersey, electric welding being used entirely, first spot-welding and then arc-welding. The door withstood greater pressures without leakage than doors made by the ordinary processes of riveting and calking. Electric welding can be used to great advantage on work inside the hull and on deck-houses, hatches, and the rest of the superstructure. Some saving of money can be made in this way, and, what is more important at present, the ships can be completed in less time.

A test is to be made of electric welding on the main hull of a ship at the plant of the Federal Shipbuilding Co., at Newark, New Jersey. Part of the hull is to be riveted and part welded, and the two parts compared and tested. For the welding work, the plates are to be assembled rapidly by spot-welding, the welds being about ten inches apart. The structure then becomes a house favorable for work in all weather and also at night. After the spot-welding has been done, the seams will be finished and made water-tight by arc-welding.

Electric welding saves the template-makers' work, the markers' work, the punching, and large part of the work of the bolters and fitters. The problems of fitting in place the parts of a hull are almost entirely problems caused by the necessity of making a number of holes in a plate made by one man at one time fit a number of holes made by another man at another time and another place. As soon as holes are omitted from the material, all the parts fit. 'Creeping' and kindred problems so perplexing to the shipbuilder disappear. However, while welding will probably ultimately supplant riveting entirely for ship construction, this is not likely to occur in the near future. The process is so new, and requires such changes in the erection of material that our present shipyards, equipped as they are for construction by bolting and riveting, could probably not be diverted economically to the welded ship. Special equipment would be needed, and possibly a specially designed type of ship.

*Abstract from 'Emergency Fleet News.'

COMPACTING CONCRETE IN WALLS BY JARRING THE FORMS

Reinforced concrete for building walls is commonly mixed quite wet and is usually compacted by spading it. Concrete containing less water, and of a quaky rather than fluid consistence, is sometimes specified; but it cannot be tamped economically in thin reinforced walls. However, it can be compacted by striking the forms and the reinforcing bars with a light wooden maul. This suggests the possibility of using a pneumatic hammer for this purpose, for a large number of sharp light raps should be effective in causing the concrete to settle in the forms.

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The Need of Americanization Both as a War and as a Peace Measure

In a speech delivered before the Americanization Conference at Washington, Franklin K. Lane, Secretary of the Interior, said in part:

"Now there are several things which we have come upon recently which seem to those of us who have not been wise to be discoveries. The first is that we have a great body of our own people, five and a half millions, who cannot read or write the language of this country. That language is English. And these are not all of foreign birth. A million and a half are native born. The second is that we are drafting into our army men who cannot understand the orders that are given them to read. The third is that our man-power is deficient because our education is deficient. The fourth is that we ourselves have failed to see America through the eyes of those who have come to us. We have failed to realize why it was that they came here and what they sought. We have failed to understand their definition of liberty."

This, then, is our danger within, the aliens not yet Americanized. Ignorance of our language bars them from becoming loyal Americans. The foreign-language press only too often distorts the truth in the interest of some propaganda hostile to America and its institutions. This is an evil condition in time of peace and a direct menace in time of war. It is such a condition that led to the downfall of Russia, which, because of its ignorance and its lack of national unity, became the dupe of political adventurers and German agents.

It is a menace that we are drafting into our army men who cannot read their orders or understand the military signals. It is a menace that our industries are largely carried on by foreign laborers who care nothing for our success in this War, and therefore not putting their best efforts into the daily work. Decreased production, labor troubles such as strikes, or sabotage, and accidents in industry, all constitute a menace, for anything that curtails the supply of food or clothing or munitions to our troops is as dangerous as German bullets.

Fortunately, the remedy is in the hands of the patriotic leaders of industry. It is up to them to develop a spirit of loyalty to America among their foreign-born employees. Employers can do this effectively. They can first of all encourage the learning of the English language among their employees. That may be through classes in the plants, such as Henry Ford developed in Detroit. Or it may be in co-operation with the local schools, enlarging their scope so that the adult foreigners can have every facility to acquire our language. At present such schools receive scanty consideration. In the Americanization conference it was stated by Dr. Wheaton of the U. S. Bureau of Education that in Fort Wayne $14,672 was spent last year in teaching German as against only $108 for teaching English and citizenship to immigrants. In Philadelphia $70,000 was spent for the German courses and only $11,000 for English and citizenship. In Columbus $16,000 was spent for teaching German and nothing for teaching our own language to the adult foreigners.

The big employers of labor in a city can bring their influence to bear on the local board of education to reverse figures like those quoted above. Surely it is for the safety and welfare of American industry that our workers should understand directions for work, safety instructions and signs, and that they should not require foremen that speak a foreign language in order to do their work properly. Many employers have found the knowledge of English such a valuable addition to the worker's efficiency that increased pay or promotion are given to those who learn the language. Other firms have classes in the plant on company time, and regard this measure as business efficiency, not as philanthropy.

Instruction in the duties of citizenship should go hand in hand with the teaching of English. The advantages of becoming naturalized should be brought home to the alien, and he should be encouraged to take out first papers and should be taught the legal forms for securing final papers. Patriotism to the land of his adoption can be stimulated among foreign employees. Noon-day talks in the factories, patriotic posters, liberty-bond and thrift-stamp campaigns will develop loyalty if the employers persist in Americanization work and are not satisfied with a brief and spasmodic effort. Patriotic literature and speeches in the native language of the immigrant will secure the attention of those who have not yet learned English. But all the patriotic utterances will be wasted effort, unless at the same time the spirit of fair play is observed in our dealings with the alien employee. Instead of discriminating against him, he should be regarded as a guest of the nation and an asset to our man-power. If he is housed in slum-tenements or shanties, he will have little love for a land that treats him like an animal. If he is under-paid, over-driven, and socially ignored, he cannot feel the affection for America that will cause him to work for it and sacrifice for it. All this is no longer theoretical nor is it to be classed as philanthropy, charity, welfare work, or as an effort at paternalism on the part of a kind-hearted employer. It is a straight business proposition. Certain successful and practical business men realized this years ago and took steps accordingly, not so much because their hearts were soft as because their heads were hard. They found it good business to keep their employees at their best, just as it is good business to keep the plant buildings in repair and the machinery in running order.

One reason for Americanization is that the knowledge of English reduces the danger of accidents. The effi-

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ciency engineer of the Semet-Solvay Company of Detroit says:

"I should be afraid to estimate the aggregate amount of waste each year to this company through a non-English-speaking operative's failing to understand an order, with a resultant costly blunder. I have known a single blunder to cost as much as $200. Then there are thousands paid out because of injuries, many of which may be traced directly to the inability of the employee to understand English."

John R. Lee, formerly in charge of the Sociological Department of the Ford Company, says:

"Ignorance of the English language has taken a vast toll of life and limb in hazardous industrial occupation; foreign-born men have been unable to understand orders given in English, with the result that thousands of them have been maimed and killed. As a result of instruction of the men at the Ford plant the number of accidents has decreased remarkably."

Another reason is that Americanization increases efficiency. The firm of D. E. Sicher & Co., a muslin-goods plant of New York, employs a large number of foreign-speaking employees many of whom are illiterate immigrant girls. A co-operative scheme has been devised whereby the company furnished a class-room and partly financed the plan, while the New York Board of Education furnished teacher, supplies, and general educational supervision. Officially the experiment was put on record as a part of Public School No. 4, thus eliminating the need of red tape in its establishment and maintenance. The purpose of the school was not only to teach English, but also to give a simple form of industrial training, to which learning English was an incident. The class was made up of factory employees. Forty girls graduated at the end of the school term of the first year, representing a variety of immigrant nationalities.

The instruction was made as practical as possible, and closely adapted to the individual's needs. Particular emphasis was laid upon personal hygiene, the relation of food to health, and the money-value of education. There was also a course in civics from a practical standpoint. The session lasted for 35 weeks. At the end of that time, forty girls were able to read and write intelligently, employing an easy but useful vocabulary of 600 words. These girls were paid their regular wages while attending the factory school on company time. Notwithstanding the fact that the employer paid these girls while attending school, the experiment was a good business investment. The improved working-capacity of these girls showed, as the result of this instruction, an actual net profit on the whole experiment. Industrially these girls were benefited not merely by increased wages, but by a better outlook toward their industry and toward social conditions as a whole. The earning-capacity of the girls attending the factory-classes before and after taking the courses offered was studied and compared with the earning-capacity of those not attending. The girls attending the factory school 32 weeks preceding the opening of the school were earning 19.5c. per hour; after 16 weeks of instruction their earning-capacity was increased to 22.5c. per hour. The girls not attending school made no improvement in their earning-capacity. The experiment now in its third year, has demonstrated that in 35 weeks the illiterate girl—foreign-born and untrained, can be transformed into a literate American woman with a good mental equipment and social knowledge essential in the battle of life.

William Sicher was asked: "Is it worth while to do Industrial Americanization work?" "It is worth while," he said, "and most emphatically so. Putting it, as you seem to do, on the basis of expense only, I will prove to you that even from this standpoint alone it is worth while, although that is not the sole motive. The elimination of illiteracy by the educational training these girls receive improves their efficiency and earning-power. This in turn re-acts favorably upon the business. They give back in efficient labor all that it cost to instruct them part of each working day. As they learn more about their work they become more interested. In imagination they see the garment grow from the raw product of the cotton-field to the finished material of the loom. We do not want cheap, illiterate, irresponsible, unambitious labor, and all progressive manufacturers are coming to see that such labor does not pay."

Another reason for Americanization is increased loyalty to the company and to the nation. Some industries are taking the stand that they will promote only men who are citizens or who have applied for their first citizenship-papers. In this attitude employers are moved by two considerations; first, patriotism and the need for national preparedness; and second, the need for an improved and more stable labor-supply and a reduction of accidents among non-English speaking men. The Packard Motor Car Co., in making its announcement of this policy said:

"We have in our organization almost 100 different peoples. We have Germans, Italians, Austrians, French, Polish, whose sympathies are divided as regards the present war raging in Europe. We have a babel of tongues and a variety of races and nationalities. Our workmen are divided into cliques. Their sympathies are with the lands that gave them birth. They forget our national ideals. This is a source of danger not only to the company but to the whole country. Conditions in the average American factory are representative of conditions in the entire country. We have no unified people, as in France, Germany, or in other countries. In the American factory sympathy and patriotism among each set of foreign-born workmen for their native land causes friction among the men. We find that in many instances men of one nationality object to working under a foreman or higher official of another nationality. We have had letters from the men objecting to employment under a 'boss' who is undesirable because of a different nationality. So we are going to make the 'bosses' in this factory Americans. Be they of whatever nationality when they come in as laborers, they must be American citizens, loyal to America and American ideals and all they stand for, before they can hope for positions of responsibility and trust. We determined to make the prerequisite of

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success in this institution, American patriotism and American nationalism. We will employ foreign-born men, but it shall be understood that their only hope for advancement and preferment lies in their speedy adoption of American citizenship and the forswearing of allegiance to other lands. And we feel that if throughout this nation commercial and industrial success depended on a prerequisite of American loyalty and patriotism, the country would be better off, its factories would have far more efficiency and the workmen would be better satisfied and happier, with old country feuds and bickerings forgotten and superseded by a thorough Americanism."

The reduction of labor turnover through such Americanizing influences as improved housing, better working-conditions, and fair handling of labor disputes is recognized as good business. More than sixty big industries that have adopted model housing as a business proposition to secure efficient and contented labor are noted in the 'Architectural Review' of April 1917. Many of the concerns have developed a system of gardens to add another link to the chain of interest that holds the man to his job.

Secretary Lane addressed every American and especially every employer of foreign labor when he said:

"We are trying a great experiment in the United States. Can we gather together people of different races, creeds, conditions, and aspirations, who can be merged into one? If we cannot do this we will fail; indeed we have already failed. If we do this we will produce the greatest of all nations, and a new race that will long hold a compelling place in the world. It is well, therefore, that we come together at such times of stress as this, and we should have come together long since and put our heads to the problem as to what are the initial steps in bringing about that harmony within our country which will give it meaning, purpose, and cohesion."

The resolutions adopted by the Americanization conference call for:

1. Adoption of a policy of co-operation between the Federal Government and the States and through the States with the local communities in carrying on an extensive, intensive, and immediate program of Americanization through education, especially for non-English speaking foreign-born adults.

2. Co-operation between the industries employing large numbers of non-English speaking foreign-born persons with local communities, State, and Federal Governments in carrying out the above policy.

3. Adequate appropriations by Congress to be expended through appropriate Government agencies for the foregoing purpose.

4. Teaching of elementary subjects in all schools in the English language only.

Trackless trolleys are operated in several foreign cities, including Rotherham, Leeds, and Manchester, England; Johannesburg and Boksburg, South Africa, and Shanghai, China. The cost of overhead equipment ranges from $5000 to $10,000 per mile.

RAILROAD ENGINEERING NEAR THE WESTERN FRONT

[The following extract from a letter, from A. B. Smith, formerly district engineer for the Road Department of Los Angeles county, California, to E. Earl Glass, of Monrovia, is of general interest.—EDITOR.]

Headquarters, 41st Engineers,
France.

The trip through England and France was interesting and I saw many things that will benefit me later. Everything that they do in either country is well done, and great pains are taken with details that we Americans overlook. In England especially, weeds along a road are unknown and they even sweep water-bound macadam every day. I saw a piece of road under construction there. They were using crushed rock about the size of our No. 1 (½ to 3 in.) and were filling it with material similar to our disintegrated granite, adding a little clay. The results appeared to be good. I believe, however, that maintenance is the secret of their success.

Grade-crossings are almost unknown in England. The highway usually crosses the railroad on a plate-girder bridge. Railroads there are fine also. At first we were inclined to laugh at their 'dinkey' engines and toy cars, but, believe me, they roll right along.

In France, of course, everything is 'shot to pieces' on account of the War, but in peace times it would probably rival England. The roads are in fair condition, except near the front, where it is impossible to maintain them properly. They are all water-bound macadam. The materials have been, in many cases, hauled for considerable distances. Labor and transportation are cheap. Soil conditions, in our vicinity at least, are bad. It rains almost constantly, and, as the soil resembles our adobe, the water does not soak into it, but lies on top of the ground.

At present we are building a railroad to a sawmill. We are obliged to lay slabs from the logs under the ties in order to keep the rails above ground at all. Our main line is standard-gauge and we have several miles of 2-ft. gauge for logging. I have charge of the construction, maintenance, and operation of the standard-gauge line, so consider myself a railroad president at last. Supplies of all kinds seem to be plentiful, in fact, more so than in the United States. We get some material from the French and British, but most of it comes from the United States. Our railroad is a sort of international affair as we used French ties and American steel, and have a Belgian locomotive or 'machine' as they call it here.

ARTHUR B. SMITH,
First Lieutenant, Company C,
41st Engineers, U. S. National Army,
American Expeditionary Force, via New York.

By-product coke-making plants in the United States number 54, with 7495 ovens. The annual capacity of all the plants is 26,005,400 tons of coke, 86,658 tons of ammonia, and 11,646,000 gal. of toluol.

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HEAT TRANSMISSION THROUGH VARIOUS BUILDING-MATERIALS

Bulletin No. 102 of the Engineering Experiment Station of the University of Illinois, 'A Study of the Heat-Transmission of Building-Materials,' by A. C. Willard and L. C. Lichty, has recently been issued.

The following formula is given for computations:

$$U = \frac{1}{\frac{1}{K_1} + \frac{1}{K_2} + \frac{X}{C}}$$

where U = heat transmitted in British thermal units per square foot per hour per degree of difference of temperature, inside to outside of wall.

K_1 = coefficient for interior surface of wall.
K_2 = coefficient for exterior surface of wall.
C = coefficient for material of wall.
X = thickness of wall in inches.

The values of K given below are for still air. For interior walls K_1 may be taken as equal to K. Where the average wind-velocity during the heating-season is about 15 miles per hour, K_2 may be taken as equal to $3K$. The values of C that are marked with an asterisk are for the thickness and construction stated, not per inch of thickness. For these values, X should be taken as 1, not as the thickness of the wall.

Coefficients of Heat Transmission

Material	C	K
Brick wall	4.00	1.40
Concrete, 1:2:4 mixture	8.30	1.30
Wood (fir, one surface finished)	1.00	1.40
Corkboard	1.00	1.25
Magnesia board	0.50	1.45
Glass	2.06	2.00
Two-inch tile, ½-in. plaster on both surfaces	1.00*	1.10
Four-inch tile, ½-in. plaster on both surfaces	0.60*	1.10
Six-inch tile, ½-in. plaster on both surfaces	0.47*	1.10
Asbestos board	0.50	1.60
Double glass with ½-in. air-space	1.50*	2.00

For air-spaces at ordinary temperatures the value of C is between 1.00 and 1.70. Increasing the thickness of the air-space greater than ¾ in. does not increase its insulating value.

The following examples will illustrate the use of the table: Given a brick wall 18 in. thick and assume $K_2 = 3K$. Then

$$U = \frac{1}{\frac{1}{1.40} + \frac{1}{4.2} + \frac{18}{4}} = 0.18$$

Given a 13-in. brick wall backing 4-in. hollow tile with ½ in. of cement plaster on each side of the tile and the same assumption as to K. Then

$$U = \frac{1}{\frac{1}{4.2} + \frac{1}{1.10} + \frac{13}{4} + \frac{1}{0.60}} = 0.165$$

In considering heat-transmission across air-spaces, it should be remembered that heat is transmitted across an air-space by radiation, convection, and conduction. As is well known, air is a poor conductor of heat. The amount of heat transmitted by convection varies with the velocity of circulation of the air, which is, in turn, dependent on the difference of temperature of the two containing walls. For ordinary temperatures the radiation-loss is relatively unimportant. But since the quantity of heat transmitted across an air-space is proportional to the difference of the fourth powers of the absolute temperatures enclosing the air-space,† it is evident that the radiation loss will increase rapidly with the temperatures of the surfaces, even if the difference in temperatures should remain constant. On the other hand, if a solid material should be used instead of the air-space, the heat would be transferred by conduction alone. The amount of heat lost by conduction would increase only slightly with an increase in temperature, provided that the difference in temperature remain constant. An air-space may, therefore, be as effective an insulator as a solid material at low temperatures, while at higher temperatures it would not be efficient.

The effect of the relative humidity of the air on the heat transmission of an ordinary building wall is so small that it can safely be neglected in determining the total heat-loss from a building. An increase in the relative humidity of the air causes a slight increase in the value of the surface coefficient; hence the overall transmission-coefficient becomes larger. If the walls are actually wet so that they absorb moisture, the coefficient of conduction, C, may be increased considerably. For brickwork an increase of at least 25% may easily occur.

Cooling of tractor-engines was discussed by Arthur B. Modine in the 'Journal' of the Society of Automotive Engineers. The following equation is given as derived from observed average performances:

Heat to radiator = 0.40 F times heat input.

where $F = 1.0$ for L-head engines ranging from 25 to 50 hp.,

and $F = 0.8$ for valve-in-head engines for the same power range.

For a tractor the heat-loss to the radiator per minute per horse-power equals about 100 B.t.u., and for automobiles, 50 to 60 B.t.u. The following formula is given for the frontal area of the radiator:

$$\text{Area in square feet} = \frac{6000\ (\text{hp. output of engine})}{vT}$$

where v is the air-velocity in feet per minute and T is the temperature-rise of the air in degrees Fahrenheit because of its passage through the radiator.

A 5000-ft. span is being constructed on the power-transmission line of Shawinigan Water & Power Co. across the St. Lawrence river near Three Rivers. As the river is navigable for ocean steamers at this point a minimum clearance of 160 ft. is required. The towers are 350 ft. high and weigh 200 tons each. They rest on four cylindrical concrete piers 11 ft. diam. and 65 ft. deep, extending 40 ft. below the bottom of the river. Above the water-level the piers are tied together with concrete struts, forming a square 60 by 60 ft. The towers carry three wires transmitting power at 100,000 volts.

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†This is exactly true only for perfect radiators and perfect absorbers.

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Food for the War

By H. C. HOOVER

*The Food Administration is purely a war institution. Its first and primary concern is the feeding of our own people and those of the Allies, and thereby the maintenance of the strength of all men, women, and children, both there and here, and thus the strong arm of our soldiers.

The necessity for the creation of Food Administrations in all the countries at war with Germany arises solely from the situation in overseas shipping. Over one-third of the world's carrying capacity has been diverted directly and indirectly to military purposes, and of the remainder there has been an unceasing loss during the War. There is an abundance of food accessible to the seas, but there are not the ships to carry it from every point and to still conduct the War.

The first adjustment of this situation has been to isolate the more remote markets. There are today abundant stores of food in Australia, the East, and in South America. Ours and Canada's are the nearest supplies to the Allies, and better protection from submarines can be given to ships on the Atlantic lane than on other sea-routes.

Roughly, every 5000 tons of food to the Allies requires 15,000 tons of shipping from Australia, 10,000 tons from the Argentine, and 5000 tons from North America. Every steamer we can save from these long journeys means the possibility of an additional shipload of soldiers and munitions to France. If the Allies were compelled to go to these more remote markets for their whole food-supply today it would require over 2,500,000 tons more shipping than at present in use for this purpose. If North America could next year provide the whole of Allied necessities we could have 1,500,000 tons of shipping. Every ship we save is a ship built. The weight of our blow against the Germans will be limited not alone by the ships we build, but by the ships that we save. The measure of ships saved by food supplied directly from North America is, until our shipping expands, the measure of ships for our own soldiers.

If the Allies were forced to rely wholly upon the remote markets for their food, we would have no soldiers in France today. Nor will the burden grow less in the near future, for every ship we build will be needed to replace losses and to increase our army at the front. This is conservation of ships as well as of food. Therefore the whole war-food problem is simply and solely a determination of the amount of food that can be spared from North America; the marginal amount must be drawn from the more remote markets.

From this spring broad administrative issues.

First: the amount of food we can send without injury to our people, and the method of securing it.

Second: the economic measures we must adopt to protect our people from the disturbance to nutrition and commerce by this drain of supplies.

In the daily toil of all these Food Administrations there have grown up new and practical issues in matters hitherto regarded as pure science. This administrative world today views production and the feeding of human beings and domestic animals in a new light. Terms strange to the lips of all but scientists three years ago are now our daily vocabulary. One must now reduce food to its physiological value. In considering the most concentrated and durable forms for overseas transport and for the maintenance of health and strength of populations, we find ourselves constantly reducing all food-material to the three main essences, that is, protein, fat, and carbohydrates. These strange terms are daily being more vividly silhouetted against this background of world tragedy. The European food-controllers anxiously take their stocks, not on the basis of furnishing the variegated menus for dinners, but in terms of these essences.

Europe today is eating to live, and to live it matters little, for instance, whether fats are drawn from creamery butter, from margarin, from lard, or from vegetal oil or cheese. What does matter to Food Administrators is how much fat can be secured and can be delivered to the needy points with the least use of ships. To carry this instance further, as showing the far-reaching character of such calculations, I may point out to you that at one time Europe produced most of her own fats. To do this it was necessary to import a large tonnage of forage for their animals. It requires three times the tonnage to transport fodder that it does the fats made from feeding animals. Therefore, the various Allied administrations have stopped the overseas shipment of feed for food-animals, and it becomes our duty to find increased exports of fats and to direct our production to this end.

Any broad consideration of these problems requires a constant re-assessment not only of our own food-resources, but of the food-resources of the Allies and of other markets from which food may be brought to the Allied world. North America is the greatest factor in the Allied food-pool and in the final analysis it might become necessary for the Allies to live practically on North American supplies. It is therefore of importance to review our possibilities in this direction.

Our ability to supply the Allied world with food lies in four directions:

First, the United States usually produces a small surplus of food for export over and above our normal

*A speech delivered before the Pittsburgh Press Club, on April 18.

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consumption. This surplus we can export without economic disturbance.

Second, we have for years exported to countries other than the Allies. By embargo of these shipments we can slightly increase the supplies available to the Allies.

Third, we can expand the area planted, and if our harvests are normal we can thereby enlarge the surplus for export through increased production.

Fourth, our normal consumption and waste of food are anywhere from 15 to 20% more than is necessary to maintain our own public health and strength, and we can in an emergency restrict the national consumption to our need, and thereby increase our exports.

We have thus, so far as the Allies are concerned, four marginal resources, namely, our small normal surplus, the embargo, an abnormal surplus to be created by stimulated production, and a further surplus to be created by a reduction in our consumption. Our resiliency of resources in these four directions, principally the latter, is such that we can, if we have the will to do so, maintain the strength of the Allies and of our own people. All talk of famine is mere hysteria. Our world-food situation is not to be interpreted as famine; at worst, it is to be interpreted in terms of soldiers to France, or, alternatively, it can be interpreted in terms of larger shipbuilding programs.

As to what our marginal possibilities of exports to the Allies may amount to, we can gain some idea if we review the situation since our last harvest—a period coincident with the period of the Food Administration. Because of the enormous demand upon us during the previous year, we entered the last harvest with our national stocks of cereals practically exhausted. We carried over less foodstuffs to the new harvest than at any time during many years. Our herd of hogs, which is our most ready and prolific source of fat, was apparently below normal as the result of previous years' heavy exports to the Allies—and we were faced with increased demands.

Owing to the fine activities of our Department of Agriculture and to the patriotic action of our farmers, a largely increased area in foodstuffs was planted for the 1917 crop, but because of weather conditions, the harvest was greatly damaged. Our wheat yield in proportion to the area planted was the lowest in many years, and in actual quantity we had no practical export-surplus over our normal consumption of this grain. A large portion of our enormous acreage of corn failed to reach maturity, and thus its food-value fell far below normal.

If we reduce our annual production to its actual nutritive value we find that our production of 1917 is about 7% below the average of the three previous years, and in the same terms we exported an average of about 10% of our production. Yet we expect that our exports to the Allies, measured in nutritive values, will this year again reach approximately the average of the three previous years. In other words, we have had to reduce our consumption by about 7% this year in order to do our duty by the Allies.

With the increased prosperity in wide sections of the community engaged in agricultural and industrial pursuits the standards of living in these regions have been raised and the food consumption of the American people materially increased. How acute this is may be indicated to you by the fact that our consumption of beef products apparently increased by 10% during 1917. We therefore had to stem the tide of increasing consumption.

The necessity of this reduction in consumption falls unequally on various commodities, depending upon their durability, their convenience in shipping, the food habits of the people we feed, etc. Nor are we able to anticipate in advance exactly what may be required from us in these disturbed times. As illustrating both points—we originally calculated that we must ship 100,000,000 bushels of wheat this year. Owing to the deficiencies in the importation to the Allies from more remote markets, we have had to raise this total to 160,000,000 bushels and to do this out of a home surplus of only 20,000,000 bushels over our normal consumption. Therefore, to feed the Allies we must take from our normal consumption of wheat, not 16% as we originally estimated, but 30%. Thus we have been compelled to increase the intensity of our conservation during the last half of the year. Wheat products are vital as a basis of war-bread to Europe because of their durability in transport and on account of the milling and baking equipment of the Eurepean peoples.

Another instance of the disturbances in original plans arose from the two and one-half months of storm weather which paralyzed our railways. Our hogs were blockaded on our farms, and the situation not only rendered difficult the supply of meats in this period, but the flood of animals released with improved transport overcharged our storage and shipping capacity. We therefore were compelled to relax our conservation efforts for a short period until the flood passed. You can thus readily see that there can be little fixity of policy in an administration that is dependent on the exigencies of war and shipping. We must alter our tactics from day to day to meet the changing world situation.

The reduction of consumption during this year has been vital. To secure it we had three alternatives of action:

First, rationing.

Second, by bidding up prices in the purchase of Allied supplies until the consumption falls.

Third, by obtaining a voluntary reduction of the individual consumption, simpler living, economy in waste, substitution of commodities that we have in greater abundance for those that we have to export.

Any system of positive rationing of the United States bristles with difficulties. Half the population are either producers or live in intimate contact with the producer and therefore cannot be restrained in their consumption by any rationing. The consumption of the very poor is not beyond the necessities of their health and strength. Our industrial population varies greatly in its habit of consumption of any given commodity in different parts of the country. Furthermore, this class of the com-

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munity varies greatly in its habit in different sections of the United States as to the commodities it consumes. For instance, the worker in the South consumes perhaps not more than two pounds of wheat products per week per capita, whereas in some parts of the North he consumes eight pounds. Rationing of wheat on any broad national line would increase the consumption beyond necessity in the South and decrease it in the North below necessity. Furthermore, to adopt rationing as a positive system would cost the Government $10,000,000 or $15,000,000 annually in bureaucratic expense, as we should have to place tickets and coupons with every householder, and behind these tickets would have to be erected a vast administrative organization.

It has been believed by many that the best adjustment in consumption would be obtained by increasing price-levels in that commodity in which it is desired to reduce consumption by simply bidding up the price for Allied supplies. I feel strongly, however, that reduction of consumption to the extent that we require by an increasing price is simply and purely to place certain commodities out of the reach of those classes of the community who have not the purchasing power, and that this whole conception is simply conservation for the rich and against the poor. The adoption of this principle of rising prices would mean that the poorer sections of our community would have paid in suffering and the richer classes would have paid in price many score times the cost of any other system of reduction.

Furthermore, if we are to increase the price of our foodstuffs merely to decrease their consumption, we must enter a vicious circle of constant re-adjustment of wages, for our working people must live. Beyond this, again, we could no doubt reduce the consumption, for instance, of sugar by 20%, if we doubled the price, but to double the price of sugar alone means an annual drain on our population of $600,000,000, and this $600,000,000 would go into the hands of a vast number of middle-men and would give rise at once to profiteering, discontent, and would lay the foundations for social revolution.

In considering the whole problem, we determined upon a line not hitherto applied and the success of which we believe will be one of the remembered glories of the American people in this titanic struggle, that is, that we should place the reduction of consumption on a voluntary basis. We felt that we could secure voluntary reduction by savings which would be made not from the necessities of the poorer classes of the community, but in the saving out of plenty by the more fortunate classes.

Voluntary conservation has also a moral side, to my mind, of some importance. By it we are appealing directly to the self-sacrifice of the people of the United States in the carrying on of the War. I do not believe that there is another nation in the world in which the proportion of individuals of a willing sense of self-sacrifice is so high as in this people of ours, and in which a sufficient voluntary reduction could be obtained. Our program therefore has been a hazard upon the number of people of this kind in the United States. This basis of reduction gave some trepidation to the Allies, for fear of its failure, but I am happy to say that we shall have performed our national duty, the Allies will have been fed during this harvest-year, so far as the obligation falls upon us, almost wholly upon a voluntary footing. Far beyond this, it is justifying us in our belief in the high idealism of the American people.

We have had some criticism from individuals who believe that they should not be called upon to do more than their neighbors willingly do. In response to this, my feeling is that our Army does not fail to go over the top because there may be two or three slackers hiding in the trenches.

Aside from the prime necessity of protecting our independence and our institutions, there is but one possible benefit from the War, and that is the stimulation of self-sacrifice in the people, the lifting of its ideals and the diversion of its peace tendencies to the purely material things of life, to a strengthening of its higher purposes. I do not say that such compensations are full compensation for war, but they are at least an amelioration of the terrible currents that are threatening our existence. Therefore we felt that if there could be brought home to the sense of every American household the necessity of this personal and individual sacrifice, we would have spread the opportunity for service beyond those who sacrifice in giving their sons to immolation on the national altar.

To accomplish this requires education; it requires an intimate understanding for each man, woman, and child in the United States of the objectives of the Government and the duty that falls upon them. We have called upon the millions of women and men in the United States with an unfailing reply. We have created great numbers of committees who have worked with the utmost devotion. We have penetrated each of our 20,000,000 households periodically with literature and we have plastered the hoardings of the country with posters. We have secured the co-operation of the manufacturers and distributers of food. We could not have attained this had we not had the absolute devotion and team-work of every newspaper in the United States. Our every appeal has, through this gigantic influence, received an immediate and prompt distribution. Without this incessant, voluntary, liberal support, our plan would have been impossible.

There is another side of all this to those of us who have lived behind the German lines. No hour goes by but our hearts are haunted by the scenes of long lines of emaciated women and children who today and for three years have gathered in Belgium for their daily bread from America. That pittance—their all—represents scarcely the waste from American tables. This winter these lines have, for the first time during the War, gathered in the poorer sections of England, France, and Italy. Not only should this pull at our hearts; it is a menace to our very safety. In the presence of a common enemy we sit at a common table with all the defenders. Is the daily call of the Food Administration for less waste, for simpler living, to eat only for strength, not a call to conscience? Is it not a vital call of defence?

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As to next year, we can formulate no plans until we know the harvest. Our farmers this year, despite great handicaps, are making the greatest of efforts. The weather is our real and final food-controller. If we have a bumper crop we can save many ships from long voyages. Even without a bumper crop, we could save more food next year. A crop failure, so far as to cause famine, is humanly impossible; the worst might compel more conservation.

The reduction of food-supplies below normal and all of the commercial difficulties connected with the aggregation of these reductions in disturbance to inland and overseas transportation have caused new currents in our economic life, and the Food Administration has, by force of necessity, had to pioneer untraveled paths in the economic jungle of war as an incident to its main purpose. For instance, there is a great deal of discussion throughout the country over price stabilization by the Government. That discussion is partly academic, partly misinformed, and most of it without any knowledge or admission of the total economic dislocations imposed by the War. So far the Government has developed no principle of price-fixing as a broad economic policy. Dislocations apply first to one great commodity and then to another, and therefore our aspect of the problem is to deal with them as they arise, commodity by commodity. We are dealing with conditions and not with theories.

Disturbance through shortage in supply, failure of inland or overseas transport, or because of the other matters with which we must contend, all lead to hardship on either producer or consumer. Our view is to review the alternative courses of action and to choose that course which leads to the lesser hardship. We are not exploiting economic reform or economic revolution. Up to the present time, and as far as I can see at the moment, what may be called the incidental policy of the Government is the only one that it will be necessary to apply, and it may be summarized in the following statement:

Every export from the United States today is under control. It is controlled that it may serve the positive military ends of the Government. All of our exports are directed to supporting the Allies, or, alternatively, where we deal with neutrals, to get the *quid pro quo* for the sacrifice of our commodities. Thus our food exports are directed toward but a few hands on the other side of the water.

With the shortage in shipping, it has been necessary for these governments to put available shipping into use for the common purpose, in order to secure the utmost expedition in loading and discharging at ports of call, and to arrange that it be loaded with the most advantageous commodities from a national point of view.

It was found by experience to be absolutely impossible to trust to the normal commercial agencies to select the prime commodities necessary for national existence among the Allies and to trust to the incidental operation of trade to maintain the maximum handling of shipping. Furthermore, these commodities are distributed by their governments under rationing systems, and thus must, in any event, come into government hands. Therefore the European governments have been compelled to undertake, as the consequence of shortage on supplies, the single-handed purchase of their supplies both for civil and military purposes. There has thus grown up an enormous consolidation of buying of 120,000,000 European people, a phenomenon never before witnessed in the economic history of the world.

Furthermore, we have aggregated in this country something like 2,000,000 men under arms, and we shall probably expand our forces to three or five million before we are finished. The buying for these men is necessarily concentrated in one agency, instead of 5,000,000 separate agencies as before, and we have thus a second great engine growing up in our midst as a necessity of war conditions. In order that these two buying agencies should not get in each other's way, it has been necessary to place them under joint direction. In the final outcome, therefore, we find ourselves in the presence of a gigantic monopoly of buying just as potent for good or evil as any monopoly in selling, and in many instances either making or influencing prices. Therefore, not through any theory, but through an actual physical fact, the price made by this gigantic buyer dominates the market.

This is price-fixing in a light never contemplated in economic history or theory, and it is time that economic thinkers denude themselves of their procrustean formulas of supply and demand and took cognizance of it. In commodities where this situation arises, the Government must necessarily regulate the price, and all theories to the contrary go by the board. So far among food commodities only wheat is positively involved, and pork prices are influenced by the volume of buying.

It is entirely possible for the Government to make these purchases to the best advantage of the Allies and of the Army and Navy and to disregard totally the civilian population, either the consumer or the producer. Where these purchases aggregate such a volume as to make inroads on the normal consumption of the civilian, it would mean that the residue would go to the highest bidder. This would be conservation again for the rich and not for the poor, with a vengeance. Had we allowed this to go on in wheat, flour would today be $40 per barrel, instead of at a universal price of practically $12.

The producer is also subject to damage by these great buying agencies. Production of food does not take place evenly over the year; it is seasonal. It is entirely possible for such a monopoly to manipulate prices in the season of surplus marketing to figures below the producer's cost. Again, transportation both inland and overseas is subject to every vicissitude of war. Temporary stoppages in transport can produce speculative disaster unless some stability is given to markets. Therefore both sides, consumer and producer, must be safeguarded by wise direction of this buying power, and this is bound to result in price regulation in certain commodities in just protection to both.

But right at this point arises to me a fundamental principle in national war economics. I do not believe

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that any person in these United States has a right to make one cent more profit out of any employment than he would have made under pre-war conditions. I do not care whether this refers to the farmer, to the laborer, to the manufacturer, to the middle-men, or to the retailer; to me, every cent taken beyond this standard is money abstracted from the blood and sacrifice of the American people.

I do not believe that extortionate profits are necessary to secure the maximum effort on the part of the American people in this War. If we are going to adopt that theory, we have admitted everything that has been charged against us of being the most materialistic, the most avaricious, and the most venal of people in this world. If we are going to admit that the Government, in order to secure the supreme efforts of its citizens in production must bribe them with money for this extra exertion, we have admitted a weakness of American character, of American civilization, and of American ideals that puts us on a plane below German kultur.

Do not mistake, I am not saying that prices and wages should return to the pre-war normal, because the incidence of war before we joined in it had lifted our costs of operation, and there must be compensation in every direction. Nevertheless, I hold that any man who has made more than his necessary living out of the cost this nation is giving in blood of the boys we are sending to France should not stand out as a benefactor to his community.

I have had this statement met before now with the expression that it is dreamy idealism, but I have found no individual who was prepared in his own instance to defend any such line of action. It is true that this doctrine has been made law only to the larger food trades. I am confident that profiteering has from a national point of view disappeared in the regulated food trades, and in consequence my belief is that it should be applied generally to all business in this community, and it is also my belief that before we are finished with this War, that will have been done.

To me, this goes much further than the mere case of the individual and the blame that may be attached to him. As I have seen this War develop from an active participation in its backwash and misery since its first day, I have seen growing out of the masses of people in every country aspirations for a great economic change. That change, broadly, will be, in the view of extremists, that those who work with their hands will obtain a larger portion of this world's goods and those who work with their brains will obtain less, while those who do not work will probably obtain nothing.

If we are to bring about this economic change in an orderly and American way, and not by convulsions during the period of recuperation from the War, we must lay the foundations for it now. None of us wants a repetition in the United States of the history of the last twelve months of Russia. The proper social development of this country along these lines fills the background of all men's minds and its proper guidance rests upon the liberal and thinking men of the country.

The enforcement of this law against profiteering in the food trades is a considerable part of our anxieties. In order to determine how far we have succeeded, that is, how far the margin between the producer and consumer has been diminished, we maintain positive data in our organization. To illustrate this, we have calculated a price-index based upon the food-values of the principal commodities. For instance, a rise of a half-dollar per dozen in eggs would be a good headline, but it is not as important to the country as a rise of a cent per loaf in bread. Upon this basis we find that since the Food Administration was founded the price of food commodities has increased 18% to the producer and at the same time it has decreased 12% to the consumer. The margin is thus smaller by 30%, in fact, it is now so narrow that price-charges to the producer directly reflect to the consumer, and the Food Administration has to take all of the curses of both sides.

This has been accomplished largely by voluntary co-operation of the food trades. Ninety-five per cent of our traders desire to serve the common interest and the measure of their co-operation is one of the most illuminating proof of the high sense of service in our people. While isolated instances will occur, I am convinced that at no time in the last three years has there been as little speculation and extortion in the nation's food as there is today.

Another economic theme which the Food Administration has had to pioneer is that of saving. Speaking broadly, we have some thirty-six millions of able-bodied manhood. We have already had to divert two millions of these men to actual arms. Beyond this we have had to divert a vast number of men to provide munitions not only for ourselves but for the Allies. We have had to divert vast numbers of men to the provision of the raw materials for these shops. We have had to set aside larger amounts of our foodstuffs for the Allies, and consequently there was a diversion of farm production to this purpose. Altogether, a rough calculation indicates that already we have diverted from eight to ten million men from their normal occupations toward war and the products it requires. That is from one-quarter to one-third of our normal productive units. It is possible that we can increase the exertion of the remainder of our productive population by eliminating non-essential labor, by more intensive labor and longer hours, by the application of woman's labor, by putting the boys into labor earlier than otherwise, and can make up some of the gap in our productive units. We cannot, however, compass the whole, and the deficiency can only be overcome by the reduction in the consumption in commodities.

This does not apply to food alone, it applies to every commodity of which we consume more than is necessary for our health and comfort. We must strip to the bone in order that we may afford the economic luxury of the diversion of this portion of our productive power to the destruction of war. If we do not, our exertion in this War will stop short of the task imposed upon us, and we cannot look to victory with any assurance.

When we survey the economic field in detail, we neces-

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sarily find difference in the degree of the essential character of commodities and labor. There are some commodities and some labor that we do not require at all, and all that we can turn to our shipyards, our munition works, and the Allied food supply is a contribution to war.

Too much economic thinking is done in terms of money. If we could, like Germany, reach that point of economic balance where the increased productivity of our home population and the decreased consumption of our home population affords the complete supply of men and commodities needed in war, we could fight for the next fifty years without economic loss. Money becomes purely the counters through which distribution of those commodities and labor is obtained.

If we subscribe for one Liberty bond from our normal surplus income, we will have furnished the Treasury with some of its necessary counters, but if we subscribe for another Liberty bond from the savings that we make on the consumption of commodities and labor we will have contributed these commodities or this labor to the War, and our second bond will have done two duties. Without it, neither the Treasury will have enough counters, nor our fighting men enough supplies. The subscription of Liberty bonds is no sacrifice for the American people. The Government is agreeing to re-pay you. It is the saving that we make in the consumption of commodities and in the employment of labor that is the sacrifice for the winning of this War.

Another prime economic theme by which I am impressed in this War is this: The American ideal in executive work is efficiency, but efficiency does not alone mean the best appliances and the greatest number made for the least cost. In war it involves a new factor that transcends all others—speed. Many of our present difficulties arise from our inability to get away from our trodden interpretation of the word 'efficiency,' and many of them from the fear of our executive officers of criticism if they fail in popular interpretation of this term.

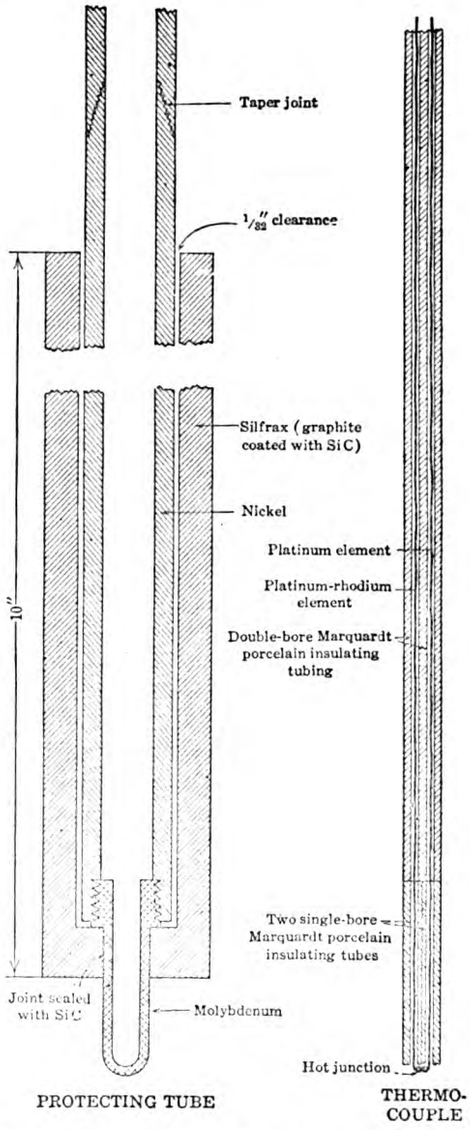
In this light the measures taken, the results attained, cannot be judged by the microscopic inspection of the threads in the tapestry—its broad lines, its inspiration, must be attained quickly, not by years of careful development. It will be of no avail to us if we lose a war, though it cost less per unit than any war in history.

We are a discouragingly critical people. Those of us in Washington are damned if we do, and damned if we don't.

There is but one real test for Washington. Our game is to win the War, and the test is, do we keep our eyes on the ball? For, friends, this people will be cursed for the next ten generations if we don't. Nor does this test apply to Washington alone. We in the Government can often criticize also, and our right of criticism lies against that minority of people who hope for self-interest out of winning the War. This Government is nothing more than the expression of the people, and if we are to win the War, it will be only because every man, woman, and child charges himself daily and hourly with the test, does this or that contribute to win the War?

BUREAU OF MINES PYROMETER

To measure satisfactorily the temperature of molten metal a pyrometer that will combine accuracy, long life, and speed of reading is essential. No pyrometer on the market is fully satisfactory for this purpose, but in the Bureau's work one was devised that has given good service for laboratory use. The illustration shows the details of the instrument. The protecting tube consists of a nickel tube tipped with molybdenum and encased in another tube made of silfrax (graphite coated with SiC), as shown. The thermo-couple consists of a platinum element and a platinum-rhodium element carried in Marquardt porcelain insulating-tubing. The graphite and molybdenum come in contact with the molten metal, but neither is attacked by it. The nickel tube resists oxidation. The small molybdenum tip heats up quickly, the lag of the device averaging 50 seconds in metal at 1200° C., with the tip cold at the start. Other nickel tubes are threaded into the lower one to give a tube three or four feet long, and the outer end is fitted with any suitable handle.



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Economics of Long-Span Bridges

By CHARLES EVAN FOWLER*

Theoretical considerations in the design of long-span bridges are usually of secondary consequence, and in preliminary investigations need only be taken into account as factors of minor importance. The situation of a long-span bridge and the length of span or spans are in the great majority of cases, determined from practical considerations, and only the maximum, or perhaps the economical, span-length that is possible need concern the engineer. Sir Benjamin Baker stated in 1882, in an address on the Firth of Forth bridge, "It is not the physical features of the country, but the habits of the population that renders the construction of a 1700-ft. span [bridge] expedient." The decision of the elder Roebling to design a 1595-ft. suspension-span across the East river at New York may be ascribed to much the same reason, although in both cases the length of spans was finally determined from the proper and possible positions for piers and the considerations of ocean commerce. The site of the Quebec bridge was determined because of the desire of the people for a direct route of travel, and the span-length was determined from the most practicable location for piers.

The principles, which may be taken as governing the planning of a great bridge, were set forth in 1914 in a discussion by me before the American Society of Civil Engineers.

"Long spans are seldom contemplated or built from motives of economy, but are the results of the necessities of commerce, of finding good foundations, or as necessary connecting links in lines of traffic and communication, regardless of whether the structure in itself will be a paying investment. When, from some cause or other, long spans are found to be necessary, the engineer must determine the class of structure that will be possible:

1. To carry the class and quantity of traffic to be imposed or cared for.
2. That will be possible, due to the foundations that can be obtained.
3. That will be possible, due to the material that can be obtained from which to fabricate it.
4. That will be possible, owing to the limitations that may be imposed by the methods and means of construction.
5. That will be a paying investment from a dividend-paying standpoint, if that be necessary.
6. That will at least be possible from related financial conditions.

"These factors are correlated to such an extent that a very wide investigation would be necessary, in order to set the limits of span and expenditure."

When therefore we find long spans to be necessary, we either know, or must determine, the classes of traffic to be carried; whether the bridge is to be wholly for railroad use, for rapid-transit suburban traffic, for highway traffic, for a combination of two of these classes, or for all three. Railroad traffic may be subdivided into freight and passenger. Frequently where freight is not to be handled, the passenger traffic is served by the rapid-transit lines. The Hell Gate and Quebec bridges are structures primarily built for railroad traffic; the East River bridges at New York are for rapid-transit and highway traffic; and the proposed North River bridge at New York and the proposed San Francisco bridge would provide for all three classes of traffic.

When the class of traffic it is necessary and advisable to handle has been determined, an accurate statement must be compiled of the amount of present traffic, and of the rate at which it has increased in the past. This statement is the basis for determining the rate of future increase. The possible future rate of increase must be studied carefully to determine the possibility of a change because of the opening of new residence or industrial districts in some other direction, which would reduce the estimated normal increase of traffic for the structure under consideration. The probability of additional bridges or of the construction of tunnels in practicable situations and for classes of traffic that could use them, must also, among other things, be taken into account.

When the normal and safe rate of increase has been determined the engineer must use his best judgment in deciding for how long a period after the completion of the structure to provide facilities. The two most important factors to consider, are: first, the financial question and second, the life of the structure. The question of finances will be in a large measure determined by the opinions of those furnishing the money, as to what amount it is advisable to invest, weighing of course the possible or most probable earnings year by year, the changes that are likely to take place with regard to general financial conditions, and the probable changes in the attitude of the public toward public-service corporations. My opinion is that at the present time or at least in the near future it will be necessary to take the public into a virtual partnership in such large undertakings. As the least concession that can be made in this regard, the structure should become the property of the public upon amortization.

The life of a long-span bridge is usually determined by obtaining data as to the life of bridges that have been built and replaced and as to the rate of deterioration that has taken place in existing structures. The life so determined and usually accepted as correct is approxi-

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mately forty years. There is, however, no reason why a bridge of steel and masonry should not last indefinitely if rust, decay, deterioration, and destruction by natural causes are considered and provided for in the design and erection of the structure. Although we cannot expect bridges to last for thousands of years, as have the pyramids, we can and must plan our great structures to last for centuries instead of for only decades. The Roebling, or first Brooklyn bridge is a striking example of the reason why 40 years of life has been assumed for long-span bridges. The cables have enough strength to carry a new deck and present-day traffic. Although the expansion rollers on the tops of the stone towers are frozen, these towers have, by their elasticity and by the yielding of the foundations, carried the loads and can carry still heavier ones. On the other hand, the deck and the stiffening trusses, because of exigencies of finance and politics, were built so light as to require replacement years ago.

The length of span or spans is to a large extent determined by the position of foundations that are practicable. This was true for the Quebec bridge and also the Firth of Forth bridge where the piers were built at the only practicable positions, the island of Inch Garvie and at the Fife and Queensferry shores. Because of Government requirements the only pier positions for bridges at New York across the East river were inside the pier-head lines. The only positions possible for piers for a bridge across the Hudson river are inside the pier-head lines in order to comply with similar Government requirements, also a pier near the centre of the river is impossible on account of the great depth to bedrock. The pier positions for a bridge across San Francisco bay at Goat island must be fixed to comply with Government requirements for facilitating commerce.

For the superstructure of a long-span bridge there are five grades of steel, high-carbon steel for compression members, nickel steel, chrome steel, or chrome-vanadium steel for tension members, and high tensile-test wire for the wire cables of suspension bridges. High-carbon structural steel is usually the best material for compression members. Given proper fabrication, relatively high unit stresses may be safely employed. The use of nickel steel for the tension members of long truss-spans or cantilevers is always advisable. Nickel-steel eyebar-chains cost about the same as wire cables for long-span suspention bridges, since, while wire cable weighs less, its cost per pound is greater. The future use of chrome-vanadium steel depends largely upon the progress that is made toward a more uniform product.

The design of a great bridge is often thrown open to competition, which makes it necessary for the engineer to produce a plan for the least expensive structure, usually requiring the least possible weight. This is accomplished by using high unit stresses for a steel of the highest practicable strength, and usually produces a structure of too great elasticity. On the other hand, a bridge designed without competition and to have as great rigidity as is consistent with good engineering and good financiering, is a considerably heavier and more costly structure. It will, however, meet more nearly the requirement of lasting centuries instead of decades. The engineer must certainly employ metal thick enough to provide against a possible reduction in the strength and life of the bridge because of corrosion. Up to a certain point this extra weight contributes to the rigidity and life of the structure. American engineers have seldom given due consideration to the fatigue of metals, but the use of impact formulas is growing in favor, the result being an increase in the amount of metal, which also helps to resist fatigue and prevent a destructive elasticity.

The problems of erection must be studied as a preliminary consideration in determining the length of spans to be used and the system of construction. There are, however, no really insoluble problems of erection, even for the greatest length of spans economically possible, nor for any system of construction, whether fixed spans, arches, continuous girders, cantilevers, or suspension spans are used. There is, however, a grave possibility of making an error of judgment in deciding upon an erection scheme, although it is almost inconceivable that any engineer competent to plan a long span should fail to determine the logical method. Nevertheless many engineers apparently have believed that erection problems should be solved by the contractor. For example, the method of erection of the Williamsburg suspension bridge of 1600-ft. span at New York was left almost entirely to the judgment of the contractors. As there were separate contractors for the Manhattan and for the Brooklyn towers and approach spans, an excellent example was afforded of a difference in judgment involving grave errors. The contractors for the Brooklyn towers, which were approximately 300 ft. high, constructed a combination truss-span between the separate masonry piers, and on this built a temporary tower for the full height from which to erect the permanent steel tower. When I, as consulting engineer for the contractors, studied the problem of erecting the New York towers, I saw that the logical procedure was to erect the towers, including the cross-girder and bracing, as far as the roadway-level, about 150 ft., by means of stiff-leg derricks placed on the double end-bent of the approach-span falsework, and then to erect the remainder of the steel tower by means of a temporary wooden tower extending only from the cross-girder to a height of about 150 ft., thus saving thousands of dollars.

The methods used in the erection of the wire cables of great suspension bridges are too well known to merit discussion here, but the methods used or proposed for the erection of eyebar chains for suspension bridges have not been generally studied. In view of the fact that the chains of the new Elizabeth bridge at Buda-Pesth were erected on falsework, it was only natural that European engineers should fall into the error of assuming this to be the only method possible, when discussing the long spans of this type proposed by Gustav Lindenthal for the East River and the Quebec bridges. Whereas the designer showed later that there was need only for a temporary wire-rope span of strength sufficient to carry

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from two to four eyebars per panel, thus forming the nucleus upon which to place the additional bars.

The erection of arch bridges is readily performed in an economical manner, by cantilevering, as was done at St. Louis for the Eads bridge and also in a more logical manner for the Hell Gate arch. The erection of the White Pass arch in Alaska was accomplished by using end-spans of the anchor-arm type, erecting the bridge from each side to the connection at the centre pin, and then cutting the bottom-chords of the side-spans next the skewbacks. Practically all cantilever bridges of long span have been constructed by building from either side until a connection could be made at the centre of the suspended span. The failure of the first Quebec bridge, although mainly for reasons independent of the erection scheme, caused the change to hoisting the suspended span for the second bridge, after the method used for the 430-ft. spans of Stephenson's Menai Straits tubular bridge.

Long fixed spans are usually put together on falsework, as was the case for the 550-ft. spans of the Huntington bridge at Cincinnati, and the recent 721-ft. span over the lower Ohio river. Long fixed spans have often been floated into place, and occasionally have been launched; as was done for the new Lachine bridge on the Canadian Pacific railway. The first Lachine bridge was a continuous girder designed by C. Shaler Smith, and was erected as a cantilever, as was also his high bridge across the Kentucky river; the chords being cut afterward at the point of contra-flexure, thus making it a true cantilever. The continuous-girder bridge on the Chesapeake and Ohio railway over the Ohio river at Sciotoville, designed by Mr. Lindenthal, was erected by assembling one span on falsework and erecting the other as a cantilever, with the aid of certain intermediate bents. Draw-bridges of great span may be erected on the draw-rest as falsework, or they may be erected as balanced cantilever-arms. Thus we see that in most instances the methods of erection are fixed by practice and precedent, but that they may often be modified in the interests of economy or good engineering.

The basis upon which the amount of future traffic is to be determined, has already been discussed. When the number of passengers, the number of vehicles, the number of cars or tons of freight have all been fixed, the engineer must determine what charge the traffic will bear, not only for today, but as nearly as possible during the life of the structure. Then, presupposing that a careful estimate of cost of the bridge has been made; the annual repair cost determined; the charges for depreciation, interest, taxes, and other general expenses fixed, he is in a position to calculate the net profit upon the necessary investment, if such a return is a condition precedent to the construction.

As has been already shown, such a direct return upon the cost of the structure is not always necessary. In fact, in the great majority of cases it does not even affect directly the financial possibility of a great bridge. The reasons for the construction of long-span bridges at the Firth of Forth, at Hell Gate, and across the St. Lawrence river near Quebec have already been noted. Similar reasons might be cited for many other long-span bridges constructed as connecting links for railway lines or systems. The great bridges at New York across the East river were all constructed without thought of commercial or financial return, and wholly as municipal necessities. For a railway structure, however, the engineer should determine whether the fixed charges for the bridge can be carried by the railway lines, or whether the possible increase in traffic will enable the additional charges to be covered at least. Where the increase in earnings of the railway system will more than pay the increased fixed charges, there is, of course, no question as to the advisability of building the structure. The municipality contemplating a great bridge must, of course, be able legally to issue the bonds for paying the cost, or else be sufficiently strong financially to obtain legislation authorizing an increased bonding limit.

A bridge that is to provide for a combination of highway, railway, and rapid-transit suburban traffic, can probably be constructed at a cost that will make it a paying investment, provided there is traffic enough in sight to balance the initial capacity of the structure; that is to say, the capacity that can be accommodated by the initial units of the structure and with ordinary speed of traffic. The initial units may be spans capable of being widened, or of having additional tracks or roadways added in the future, and of having wider and more permanent approaches added to, or in place of, those of restricted width or of temporary character.

There is no need when considering bridges with spans of the greatest possible economical length to compare the cost with a tunnel or tunnels of the same traffic capacity as a bridge; because it may be considered as axiomatic that the tunnel scheme would be more costly. There is therefore no need to discuss the disagreeable features of tunnel transit, the impossibility of ventilating a tunnel for auto traffic, and its lack of safety under certain conditions.

The approximate span-lengths that may be taken as the greatest economically possible, are for simple spans, from 700 to 800 ft.; for suspension bridges, 3000 ft.; for cantilever spans, 2000 ft.; for arches under usual conditions, 1000 ft.; for continuous girders proper, 800 to 1000 ft.; and for draw spans, 550 ft. A suspension bridge would in most cases be more economical than a cantilever structure where the span exceeds 1700 ft.; a cantilever or a continuous bridge would usually prove to be cheaper than any fixed spans that could be termed a really long span; the arch would be formed more economical than a suspension bridge for many reasonably long spans, where there are rocky banks or walls for the skewbacks. The type to adopt for any given situation depends mainly upon local conditions.

The economical number of spans to be used for any given ordinary crossing may be determined by the various formulas proposed for the purpose, but it is usually just as easy to make an estimate of cost for several bridges with different lengths of spans with their respective piers, and certainly the results attained by this method are usually more satisfactory.

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Present Practice in Building and Launching Ships*

By F. J. FRENCH†

Let us assume first that the shipyard owner is approached by a client who desires a vessel built for his particular service. His requirements will be governed primarily by ships that he already has in service; modified by the recommendations of his marine superintendent and his port engineer as to type of cargo, desired carrying capacity, draft, speed, and indicated horse-power, and further modified by that very misleading factor, 'cost per deadweight ton,' which is so widely quoted, regardless of speed required. To illustrate the fallacy of using this unit of cost, take a vessel of 5000 tons deadweight capacity and assume, from data already at hand, a speed of 10 knots with an indicated horse-power of 1500. If the owner desires his ship to make 13 knots instead of 10, it will be found that, since for normal speeds the power varies with the cube of the speed, the required indicated horse-power will be 3300. The power-plant weight and cost will, of course, be in similar proportion.

The primary characteristics having been decided, the problem now passes to the builder's naval architect, who correlates all of the factors and sends to the estimator the weights, horse-power, etc., who in turn makes an estimate of cost. In addition to the particular requirements of the owners, it will also be specified that the ship is to be built to the requirements of either Lloyd's, the American Bureau of Shipping, or some other recognized classification society, and the surveyors of the chosen society will see that its requirements are observed. The rules of the various societies specify, to the thirty-second of an inch, the size and thickness of all members entering into the structure of the ship, as well as the size and type of all fastenings; their rules being based primarily upon the theoretical strains experienced by ships subjected to the action of deep-sea waves, but modified by scores of years of experience covered by comprehensive reports of hundreds of catastrophes at sea, these reports being made by surveyors of the societies, who are themselves seafaring men and who have carefully investigated the probable causes, and possible preventive measures, in each particular case.

Let us now assume that we have a contract to furnish all material to construct, launch, and equip a ship of 5000 tons deadweight, which is 350 ft. long by 48 ft. wide by 28 ft. deep, and has engines of 1500 to 2000 hp. Perhaps, under present conditions, we have not done much more than select our site for building. A frontage should be chosen on as deep and wide a waterway as is compatible with financial and engineering considerations. The site selected should be reasonably accessible to a labor market.

The next step is to lay out building-ways to suit the water. We have a choice of two methods of launching, namely, stern first, or sideways. The stern-first method is the rule at Atlantic Coast yards, and wherever the required width and depth of water is obtainable. Side launching is largely confined to the yards of the Great Lakes and to other plants where for various reasons it is found desirable to build on the banks of a narrow waterway.

For the stern-first method the following conditions will govern: The building-ways will be so placed that the stern of the vessel will be close to the water's edge and 3 to 4 ft. above the ground. From this point back they will be given a rise of about five-eights of an inch per foot, which would put the keel-line at the bow of a 350-ft. ship 21 ft. above water. A yard having a natural easy slope toward the water is therefore desirable as facilitating the construction of the underbody of the ship without the necessity of filling to the desired grade. The building-ways consist of a series of blocks spaced about 4 ft. centre to centre and made up of 12 by 12-in. timbers 5 or 6 ft. long, set transversely and resting on piling.

The launching-ways consist of two parts, the standing and the sliding-ways. They are parallel to the centre-line of the ship and about one-third to one-half the half-breadth from it. They are constructed of heavy longitudinal timbers laid on piling and are usually given a camber of about a foot in their length for the purpose of overcoming the resistance of the water as the vessel nears the end of the ways. A customary slope is about ½ in. per foot at the bow of the ship, increasing to ¾ in. per foot below the surface and should be well supported by clusters of piles as, at the moment before the bow drops off the end, nearly half the weight of the ship bears on this point.

It will be seen at once that we meet insurmountable obstacles when we propose to adapt this method to a river such as the Mississippi, where a variation occurs of twenty or more feet. If, for example, a launching has been planned for high water and completion has been delayed for four or five months beyond the schedule, the builder is confronted with the alternatives of waiting for the next high water or of flattening the launching-ways and extending them some 400 ft. farther.

So far as building on the Mississippi is concerned, the only practicable position is upon a locked canal, and this, of course, involves a side launching. With this method, the keel is laid parallel to the bank, and instead of two

*Presented at a joint meeting of the Louisiana Engineering Society and the New Orleans Section of the American Society of Mechanical Engineers.

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sets of ways there are perhaps a dozen or more at right angles to the keel. The construction of the ways is similar to those already described, except that they may either be carried below the water surface (in which case the final camber is much greater than the longitudinal ways) or they may be stopped short above the surface and the vessel dumped off. In either case the launching is a much more delicate proposition than the stern-first method, as all the ways must be released at precisely the same instance, any variance carrying the practical certainty of disaster. With either type of ways the maximum loading per square foot of sliding-surface should not exceed 2½ tons, especially in warm weather, as heavier loading forces out the grease and chars the ways.

The next important step is ordering the structural material. This is done by the builder's superintendent from the contract plans, which consist of midship section, inboard profile, deck plans, bulkheads, and (if the vessel is to be of steel) the plating model. The latter is made accurately from the line drawing. On it are shown the exact sizes and thicknesses of all shell plates, as well as data concerning seam and butt riveting, doubling plates, longitudinals, and transverse frames. All plates are ordered to within ½ in. of the desired size and are so shipped by the mills. Every plate, channel, or angle is inspected and tested at the mill by the surveyor of the registration society and a permanent record made of its characteristics as well as its position in the finished vessel.

In the interval preceding the delivery of the material the loftsman is busy with his force laying down to full size and fairing the lines of the ship on the mold-loft floor. These lines are the intersections of vertical transverse, vertical longitudinal, and horizontal planes with the outside shell of the ship. The three views must be made to agree or the resulting surface will be unfair. In some yards the lines are first drawn and faired to a quarter-inch scale in the drawing room, the offsets or ordinates from this set then laid down and re-faired to a one-inch scale on a marble slab, and finally the offsets from the slab laid down and faired to full size on the mold-loft floor. Methods have been evolved for deriving mathematically the lines of a ship of given characterisics, but as the simplest of these methods involves the use of formulas with five variables they have not become popular. From the lines as drawn are now derived the exact contour of each transverse frame, as well as its bevel, the position of plating-seams, and the traces of longitudinal decks.

Templates of thin white pine are made of the frames and on these is shown all the information necessary to enable the shop to fabricate the frames. These templates go to the bending-floor. The frames when bent and beveled go to the punch-shop and are finally set upon the blocks and tied to the centre keel and keelson plates, which have preceded them. With the frames secured in place with longitudinals and temporary rib-bands, templates are made from the skeleton for each shell-plate. These templates are applied to the plates, which have now arrived from the mills. If the ship is known as a 'full' ship and has a considerable proportion of parallel middle body, much of this work may be done in the loft and one template be made to answer for a dozen or more plates. By applying the above principle intelligently to the original design a great amount of unnecessary labor may be eliminated, not only in the shell, but on bulkheads and decks as well. The advantages above outlined would not, of course, apply in the same degree to the construction of a wooden vessel, as in this case once the frame-templates are out, it is largely a case of cut and fit for each timber and plank.

It is reasonable to believe that by a judicious duplication of parts, by adhering as far as possible in a given yard to a given size and type of ship (as is now done in England), by reducing the number of plates which must be 'lifted' from the ship itself, and by the introduction of efficient cost-keeping methods we will be able, when the present abnormal conditions have passed, not only to hold our own but actually to take the lead in this industry.

ANTI-FREEZING SOLUTIONS FOR AUTOMOBILE RADIATORS

A careful study of anti-freezing solutions made by the U. S. Bureau of Standards leads to the conclusions based on experiment that (1) calcium chloride compounds should be used with caution, if at all, on account of their corrosive action; (2) kerosene or similar oils should not be used on account of their inflammability, high boiling-point, and effect on rubber; (3) mixtures of glycerin and alcohol can be used but the price of glycerin, and the need for it in the manufacture of munitions at the present time should preclude its use; (4) solutions made from either wood alcohol or denatured alcohol seem at the present time to be the most desirable anti-freezing solutions to use. If the wood alcohol is free from acid there is little choice between the two alcohols. Wood alcohol costs more than denatured alcohol and is more volatile, but its lower freezing point allows a less amount to be used, which may counteract the above disadvantage. The ideal anti-freezing compound is one that will prevent freezing of the radiator liquid without injuring either engine or radiator, that will not lose its non-freezing properties after continued use, and that does not materially change the boiling point of water when dissolved in it.

A rust-prevention process recommended for small machine parts is an application to the surface of the iron or steel of iron phosphates. After being cleaned thoroughly the articles are immersed in a bath containing ferric and ferrous phosphates, with a little manganese di-oxide. They are left at boiling-water temperature until hydrogen is no longer given off. The articles are then air-dried, and may then be treated with mineral oil, painted, japanned, or otherwise finished. As the phosphate surface is attached chemically to the metal, no rust forms even in cracks in the paint.—'Mechanical World.'

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Tanks and Reservoirs for Storing Oil

Bulletin 155 of the U. S. Bureau of Mines, 'Oil-Storage Tanks and Reservoirs,' by C. P. Bowie, has recently been published. Some of the more important conclusions stated in the bulletin are as follows:

The best all-round container in use at the present time for storing petroleum and petroleum products is the all-steel tanks of gas-tight construction. The standard large-size tank has a capacity of 55,000 bbl., and is 144 ft. 6 in. diam. and 30 ft. high. The tank-grade should either be all in fill or in cut, on account of the danger of unequal settlement. The soil should be compacted well. To prevent corrosion of the tank-plates, several inches of oil-sand should be spread on the completed grade, or, if no oil-sand is available, the surface should be scarified and oiled.

Although few failures of steel tanks from wind-stresses have been recorded, the 'sand-line' system of wind-bracing is advisable for large tanks. This consists of stringing ⅝-in. wire cables across four diameters of the tank, and at such distances apart that the tank-area is divided into 45° segments. Two sets of cables are generally used, one in a plane 10 ft. and the other in a plane 20 ft. above the bottom of the tank, the 'spokes' in the two planes being staggered so that the shell of a 55,000-bbl. tank is braced at intervals of approximately 20 ft. along its periphery. Discarded sand-lines from drilling-rigs are often used for this purpose, hence the name, but new cable is better, since the old cables have usually been discarded because of defects.

Explosion-doors should be placed in tanks in case of fire. For a 55,000-bbl. tank, eight doors are recommended, each with an area of 9 sq. ft. Such doors are of more importance in some of the Eastern fields, where the oil is of high-gravity and electric storms are frequent, than in California, where electric storms are uncommon and much of the oil is low-gravity.

Wooden roofs for steel tanks are objectionable, principally on account of the increased fire-hazard. In any case they should not be used for light oil because of the loss of volatile constituents of the oil.

In 1914 an all-steel 55,000-bbl. tank could have been constructed for 30 to 32c. per barrel, exclusive of excavation and pipe-line connections At present the cost is 42 to 45c. Wooden-roof tanks cost 25 to 27c. four years ago and 37 to 40c. at the present time. The life of steel tanks is estimated at 40 years.

While some oil is stored in unlined earth reservoirs, the practice is not to be encouraged. For anything but temporary emergency storage, a concrete lining is to be recommended. Most of the concrete-lined reservoirs in the United States are in California, the total capacity in that State being 19,000,000 bbl. These are used exclusively for fuel-oil between 14-gravity and 18-gravity, the lighter oils being stored in steel tanks.

In constructing a concrete-lined reservoir, special care should be taken to select a well-drained site. The general rules suggested for tank-grades should be followed for obtaining compact bottom and sides. Every effort should be made to obtain an impervious concrete for the lining. Expansion joints in the lining are unnecessary and may be positively detrimental because of leakage.

The roofs of all large reservoirs constructed so far have been of wood covered with roofing-paper. This type of construction is unsatisfactory because it permits the sun's rays to heat the upper surface of the oil and also because it offers no resistance to the passage of the volatile constituents that rise from the body of the oil because of such heating. A reinforced concrete roof strong enough to carry a covering of a foot or two of earth would not be open to these objections and would probably pay for itself in a relatively short time.

Temperature variations in a storage reservoir filled with oil are relatively small. Records secured in 1915-16 at a reservoir 20 ft. deep, near Bakersfield, California, are given in the bulletin. The temperature was observed at 7 a.m. While the air-temperature at that hour ranged from 37° to 87°F., the range of temperature of the oil 2½ ft. from the bottom of the reservoir was only between 53° and 62°F., and the range 17½ ft. from the bottom was between 53° and 73°F. The range of air-temperature for the entire year at all hours was between 32° and 106°F., but the extreme range for the oil was probably not appreciably greater than that recorded.

An oil-tight concrete can be obtained by taking care to make a dense compact lining in which all coarse material is well embedded below the surface. Samples taken from the bottom of reservoirs that have held 20 ft. of oil for as much as five years show practically no penetration. Experiments made by the fuel-oil department of the Southern Pacific Company with various so-called oil-proofing materials such as sulphuric acid, lead paint, Sorel cements, and barium sulphate, showed that concrete blocks treated with these materials were more pervious than the plain concrete.

A concrete reservoir with a capacity of 500,000 bbl. can be constructed for 10 to 13c. per barrel. An unlined earth reservoir with the same type of wooden roof will cost from 7.5 to 9c. per barrel. The estimated cost of a concrete-lined reservoir with a concrete roof on concrete supports and covered with 2 ft. of earth is 30c. per barrel.

Losses from seepage in unlined earth reservoirs are large. The experience of one company having a 1,000,000-bbl. reservoir containing 15-gravity oil near Bakersfield, California, indicated a loss of about 5% per year from seepage and 2% per year from evaporation. For lighter oils the loss from evaporation is much higher. At Port Arthur, Texas, the loss from a wooden-roof tank

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containing 55-gravity oil was 30% per year. From a steel-roof tank containing oil of approximately the same gravity the loss was 5% per year.

Devices for reducing evaporation-losses are of two general classes; first, those designed to reduce the temperature of the oil, and second, those designed to make the container as tight as practicable. The most common method of reducing the temperature is by water-seal tops. These are usually made for small tanks, up to 5000 bbl. A tank with a water-seal is constructed like other tanks, except that it has a flat roof constructed of riveted plate made water-tight and placed about 6 in. below the upper edge of the shell. The space enclosed above the plate is then filled with water that can be kept circulating constantly, thus keeping the tank and its contents cool. Experiments were made in October 1915 with two 100-bbl. tanks, one plain and the other water-sealed. The gravity of the oil was about 33° Baumé in both cases. The loss in 30 days from evaporation in the plain-top tank was 19%, while the gravity of the remainder was reduced to 27° Baumé. The loss in the water-seal tank was only 3.86% and the reduction in gravity was negligible.

Other methods for reducing the temperature of stored oil include a sprinkling device similar to a lawn-sprinkler and mounted on the top of the tank. It is arranged so that the water flows over the top of the tank and down the sides. Tanks encased with hollow building-tile are also used. Some refiners bury their tanks, partly or entirely below the surface. This is objectionable since it probably increases corrosion. Light-colored paint reduces the temperature of the tank somewhat as compared with dark-colored paint.

Small reinforced concrete tanks up to 10,000 bbl. capacity have been built in various parts of the country, mainly in Oklahoma and Texas. Some of these are circular and some rectangular. The results have been satisfactory whenever care has been taken in mixing and placing the concrete.

The bulletin gives complete specifications for a 55,000-bbl. all-steel tank and for 750,000-bbl. concrete-lined reservoir.

The shells of the long-range guns now being used to bombard Paris, according to 'Le Genie Civil,' are 210 mm. diam. The actual length is not greater than 500 mm., but this is increased to 900 mm. by a false nose of sheet metal. The shells have a fuse at the base, and, possibly, one at the nose to double the chances of an explosion. No unexploded shells have been found. The weight is between 100 and 120 kg. The thickness of the walls is between 30 and 40 mm. The internal capacity does not exceed 6 litres, which is sufficient for only 10 kg. of high explosive. The result is that the shell is broken into few pieces and the number of casualities is relatively small.

The length of belt-splices, according to 'The Dodge Idea,' should not be less than 9 in. for a double belt. For belts between 9 and 18 in. wide, the length of splice should be equal to the width of the belt. The maximum length required for a splice is 18 inches.

IRRIGATION OF RICE IN CALIFORNIA

Bulletin No. 279 of the Agricultural Experiment Station of the University of California by Ralph D. Robertson, is based on a co-operative investigation made between 1913 and 1916 under the auspices of the U. S. Department of Agriculture, the California State Department of Engineering, and the California State Water Commission. The first commercial crop of rice in California was grown in 1912, 1400 acres being planted. About 67,000 acres was cultivated in 1916, most of it in the Sacramento valley, although some rice was also raised in the San Joaquin valley. In 1916, 3700 acres was irrigated from wells and the remainder from streams, most of it from the Sacramento and Feather rivers. The acreage now under cultivation is considerably larger than it was in 1916.

Land is prepared for irrigation in contour-checks, preparation consisting mainly in making ditches, levees, and gates. The gates must be wide enough to admit the large heads of water used in the initial floodings. The irrigation season consists of two periods. Frequent light irrigations with relatively large heads of water are given to germinate the seed and to maintain growth until the plant is four to six inches high, and thereafter the land is continually submerged to a depth of six to eight inches until the rice is matured. The first irrigation is usually applied in April and submergence commences during June. The water is turned off and the fields drained in October.

Measurements of the use of water in 1916 on eighteen typical fields in Sacramento valley showed a range of from 4.27 to 14.83 acre-feet per acre, an average depth applied of 8.23 ft., and an average of forty-seven acres served per cubic foot per second. The heads of water used per acre averaged 0.052 cu. ft. per second before submergence and 0.034 cu. ft. during submergence. The lowest use was on fields with heavy retentive soil, where the preparation was good and the water carefully handled. The average annual use over a three-year period on a field near Biggs was 4.60 acre-feet per acre. During the three irrigation seasons the average precipitation was 0.23 ft. and evaporation 3.19 ft. Irrigation practice and requirements in California differ from those in the Gulf States, mainly because of different climatic conditions.

Adequate drainage is essential to sucessful rice production. Planting and harvesting are both delayed while the soil remains wet, and the removal of alkali salts and the relief of water-logged lands are dependent upon drainage facilities. The results of experiments made in 1914 to 1916, inclusive, on black clay adobe soil near Biggs indicated that thirty days after emergence of the plant is the best time for commencing submergence, and that six inches is probably the most advantageous depth of submergence. Poor yields were secured where no water was held on the land. Fluctuating the depth of water had little effect on plant growth. More uniform temperatures of the water were found with the greater depths of submergence.

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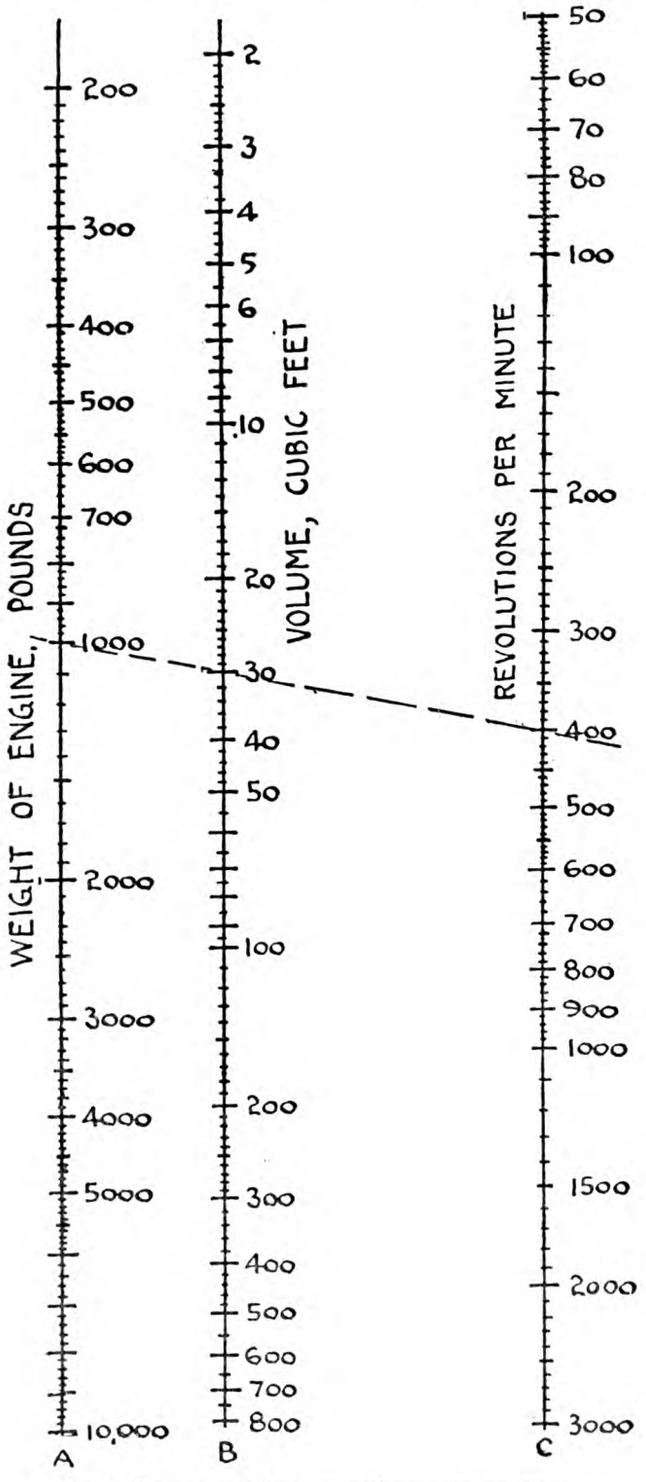
Engineers' Note Book

DIAGRAM FOR COMPUTING SIZE OF FOUNDATION FOR ENGINES

The accompanying diagram, taken from 'The National Engineer', may be used for computing the proper size for concrete engine-foundations. Thus if the weight of the engine is 1000 lb. and the customary speed is 400 revolutions per minute, the foundation should contain 30 cu. ft. of concrete to give the proper freedom from vibration.



Sizes Needed for Concrete Engine-Foundations

Industrial Progress

TUNNEL DRIVING AT UNITED VERDE EXTENSION

By D. J. O'Rourke

*To simplify the present system of handling copper ore at its Audrey and Edith shafts, the United Verde Extension Mining Co. at Jerome, Arizona, is driving a tunnel 12,384 ft. long. At present, ore is carried 4000 ft. down the mountain by aerial tram to storage-bins on the railroad. From here it is hauled to custom smelters in Arizona. The company is erecting a smelter at its property, to be finished this year. The tunnel will save much re-handling of ore, also eliminate hoisting it 1100 ft. from No. 13 level of the main shaft. From the foot of this shaft the ore will be hauled through the tunnel to the Arizona Extension railroad, on which the cars will carry it to the new smelter, three miles away.

The new thoroughfare is being driven from four headings, that is, from inside the mine, from the outside or portal end, and from both faces at the foot of the Texas shaft, sunk 613 ft. deep at a point 6700 ft. from the portal. The completed tunnel will be 9½ ft. clear above the track and 11 ft. wide at sub-grade. A ditch, 18 in. wide and 12 in. deep, is being dug at one side for drainage. Track will be laid with

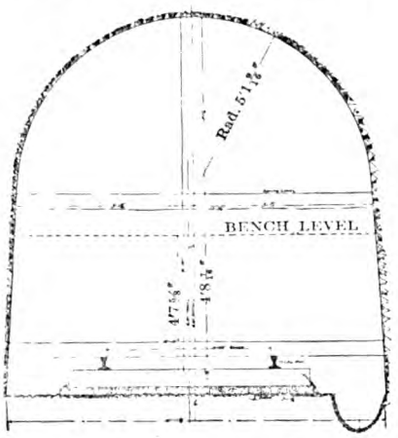


Fig. 1. Cross-Section of Tunnel.

70-lb. rails, and road-bed is to be sufficient for steel railroad hopper-bottom cars of 30-ton capacity. These are to be hauled by electric locomotive. The grade from the mine is 0.425%, or 22.5 ft. per mile. The Potter Construction Co. of St. Louis has the contract.

Rock at the portal end of the tunnel, and so far for 3600 ft., is conglomerate—a cemented mixture of sandstone, limestone, diorite, and malapai. Fragments vary from pebbles to pieces three feet in diameter. The whole is dense and tough. It carries no water. At the station end (at shaft) of the tunnel the rock was first diorite and schist, intruded by soft dikes, requiring heavy timbering—12 by 12-in. spaced 5-ft. centres.

Work was started at the portal on July 7, 1917, since when the following distances have been driven:

1917	Feet	1917	Feet
July	300	November	581
August	453	December	640
September	517	1918	
October	563	January	614

This gives a total of 3668 ft., or 524 ft. per month. As much as 25 ft. has been driven in 24 hours.

*Abstract from 'Mine and Quarry,' February 1918.

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Considerable delay was encountered in making satisfactory progress in this ground at the start, due to difficulty in getting holes to depth in the formation. First method of drilling tried was by means of self-rotating hammer-drills, holding the machines by hand for some holes, while for others the drills were mounted on cradles and feed-screws on columns. Four drills were used in the heading at one time, and holes 8 to 10 ft. deep were drilled. Hexagon hollow steel—⅞-in.—was used with cross-bits. The drills were of the water-type, by means of which a water and air-jet was forced to the bottom of the drill-hole to clean it of cuttings. After driving 90 to 100 ft. with the rotators, it became evident that the use of mounted drills entirely would give better results on account of the difficulty in keeping the holes in line when running through the uneven formation. It was also decided to substitute heavier machines for the rotators, and the Sullivan DR-6 water-jet mounted hammer-drills, with 2½-in. cylinder, and weighing 150 lb., were adopted. For a considerable period the heading was advanced with two of these mounted on double-screw mining columns, the drills being carried by means of extension arms, enabling the drill to work 36 in. from the column in drilling the side-holes to follow the contour of the tunnel.

It was later decided to increase the depths of the holes from 10 to 13 ft. Six cut-holes are used. The solidity of the bonding is well shown by the fact that with the 13-ft. cut-holes, 7 or 8 ft. of the cut are often thrown out by the first shot in a practically solid mass of wedge shape, requiring re-blasting, before it can be sent away. The cut-holes are then loaded again, and re-shot before the side round is fired. If any of the cut is still left after the second shooting, it is again loaded and shot, with the side round. The explosive used in the cut-holes, which gives excellent satisfaction, is Atlas blasting gelatine of 60% strength. Atlas gelatine of 40% strength is used to blast the side rounds and roof-holes. The side round and roof holes are fired at the same time, delay exploders being used for the roof, which is thus thrown out after the side round has gone. No relieving holes are used, as it is found that the heavy charging of the cut-holes occasionally caused ignition of the charge in the relievers at times when seams were being crossed. Four rib-holes are put in on each side of the tunnel, four holes in the roof, and four lifters, making a total round of 22 holes. The roof and side-holes are of approximately the same depth as the cut-holes.

This tunnel is being driven, as indicated by Fig. 1, by the top-heading and bench method, the work being divided between a 7-ft. heading and a 3½-ft. bench. The bench is kept within about 30 ft. of the heading at all times, and is drilled with Sullivan DP-33 water-tube rotator drills, using ⅞-in. hexagon hollow steel with cross-bits. Holes are drilled with these machines to a depth of about 5 ft. to insure reaching the sub-grade of the tunnel.

Telescopic bars or braces are placed across the tunnel, just above the grade of the bench, at a sufficient height to permit the tunnel cars to run below them. Planks are laid on these supports, serving as a runway for the barrows in which the shovelers remove the waste from the heading, and from which it is dumped into cars below. The tunnel is laid with double track of 12-lb. rail at the heading, the switch being moved forward every two weeks, and passing tracks are laid 1200 ft. apart. Steel side-dump cars of 32 cu. ft. capacity are employed for handling the rock. These are the same type and size of cars as those used on the Los Angeles aqueduct tunnel five or six years ago. Mules are used for haulage, the mules coming right up to the end of the scaffolding, which is within 30 or 40 ft. of the bench, so that practically no hand tramming is necessary. One mule hauls two cars at a time.

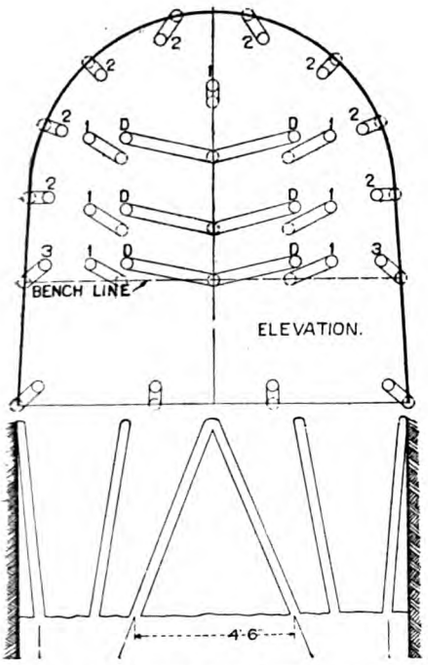
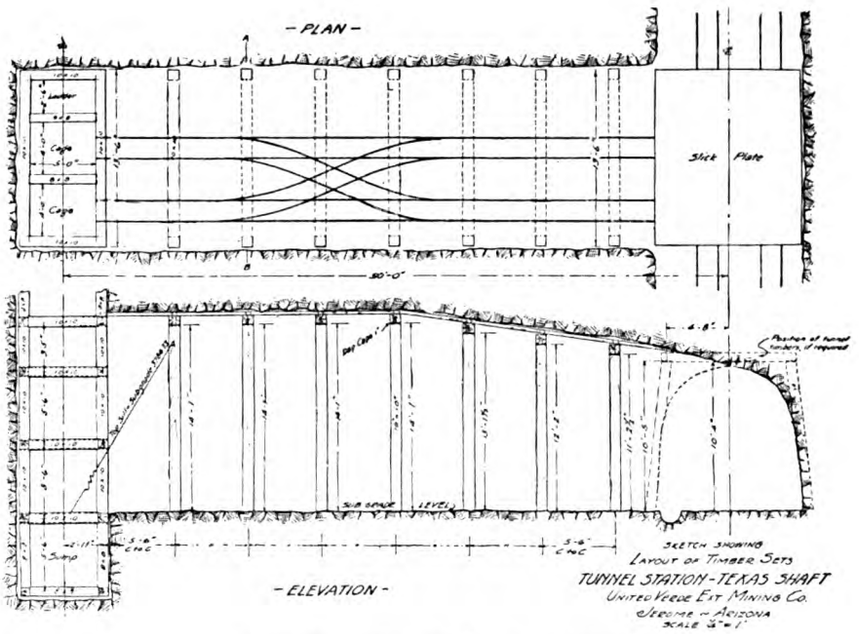


FIG. 2. DRILL ROUND AT STATION HEADING.



PLAN AND SECTION OF TUNNEL STATION.

Two eight-hour shifts are worked. The shovelers, consisting of 12 and a foreman, commence work at 8 a.m. Three hours are required to load out rock from the previous shot at the face, so that when the miners start work at 11 o'clock they are able to set-up columns and start drilling the new round. Two men are used on each machine in the heading. Under favorable conditions the holes are completed by 3:30 or 4 o'clock. The round is then shot, so that ample time is allowed between shifts for blowing the smoke. Two rotators, each operated by a single man, drill the bench. The next, or night, shoveling shift comes on at 8 o'clock in the evening, and the miners again at 11.

As stated above, about 1350 ft. has been driven from the inside or station-end of the tunnel. The problem at this heading was not one of drilling speed, but of adapting the work and organization to operations in the mine. All waste from this heading has to be handled through the main hoist-

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ing shaft of the United Verde Extension mine, or carried back into empty stopes. The cars are handled by tail-rope haulage. Trouble was also experienced in blowing-out the tunnel after blasting, so that special means for ventilation had to be devised. Finally it became necessary to draw a fresh air-supply from the Edith shaft, on the 13th level, by means of 12-in. pipe, the exhaust system being used to suck air in from the Edith shaft by a No. 8 Buffalo blower.

Due to these conditions, and trouble in timbering, it was found that a rate of advance of between 5 and 6 ft. per shift was as great as proper disposal of the rock would allow. Fig. 2 shows the tunnel round in this heading, which is practically the same as that at the portal heading, except that relieving holes are used to secure better distribution of the powder and break up waste smaller. Two Sullivan DR-6 drills, mounted on extension arms on double-screw mining columns, are used in this heading, also for drilling the heading round. The bench is drilled by means of lifter or horizontal holes put in from a cross-bar by the heading crew after they have drilled the heading round. The DR-6 drills are mounted on a bar for this purpose, and 7-ft. holes are the rule. The bench is carried up to within a few feet of the heading, and all rock from the heading thrown over the bench. The material from both the heading and bench is loaded directly into mine-cars.

The bits are heated in a Denver Fire Clay Co.'s oil-forge, and are heated for tempering in the same furnace. The bits used are interesting, being of the four-point or cross-type, with low centre, and double taper on the wings. The wings, for a distance of one inch back from the face, have a 5° taper; with the usual 14° taper from that point to the base of the wing. In the tough conglomerate formation mentioned, this double taper gave a good reaming effect, as will be seen from the fact that it is seldom that a steel has to be changed on account of lost gauge before the end of the run is reached. The low-centre bits secure the advantage that holes rarely drift as they would otherwise do frequently, due to the different angles at which the boulders are encountered. The high corners catch the hole on the sloping surface of the boulder.

ELECTRIC POWER FOR CULTIVATING FARM LANDS

Experiments made at the University Farm at Davis, California, on the use of electric power taken from a transmission-line for cultivating farm land are described in the 'General Electric Review' by J. H. Davidson and F. E. Boyd. A field 834 by 1251 ft., containing 24 acres was used for the experiments. Power was obtained from an existing transmission-line running along the short side of the field. A branch line costing $110 was run down the middle of the field. A home-made tractor designed for truck-crop work and consisting of two drivers and a cultivator was used. The tractor was designed to travel 140 ft. per minute, and was driven by a 3-hp., 220-volt, 3-phase motor. The drivers were 32 in. diam., with a 4-in. face. Three speed-reductions were required, which were effected by a belt, a bevel-gear set, and a spur-gear set. The machine carried a cable-reel, the winding or unwinding of the cable being controlled by a friction clutch. In operation, the cable was dropped at the side of the tractor when traveling away from the power and picked up on the return. The experimental machine, complete with 180 ft. of cable and the cultivating attachments, weighed 735 lb. The estimated cost of such a machine, if produced on a commercial basis, was $500.

No difficulty was experienced in handling the machine. The cable was easily managed and the fact that the machine was tethered was not so much of an inconvenience as might be expected. In hard ground, when the cultivator was set deep, the tractor would slip its drivers, while the motor developed an overload of 250%.

The following records were made of current consumption:

	Watts
Normal cultivation	1867
Deep cultivation	2500
Drivers slipping	3200
Re-cultivation on soft ground	2400
Cultivation on soft ground	2200

A draw-bar test was made by detaching the cultivator and substituting a stone-boat for the load, with the following results:

Draw-bar pull, pounds	2285
Time required to travel 100 ft., seconds	46.8
Input electric energy, horse-power	2.94
Over-all efficiency, per cent	29.8
Estimated output of motor, horse-power	2.48
Efficiency of tractor, per cent	35.5

The low efficiency of the output was probably caused by the crude gearing used and friction in the bearings, which were not in the best condition. The efficiency could undoubtedly be improved in a perfected machine.

Comparisons of performance of this electric outfit with work done by horses is difficult. The tractor could cultivate 8 acres in 8 consecutive hours, whereas the same work with a single-horse outfit would require 11 hours, which could not, of course, be consecutive. In cultivating the 24-acre field with the tractor there would be a saving of $7.50 plus 1½ days' time of the operator. A liberal estimate for the cost of the electric outfit is $610, $500 for the tractor and cable and $110 for the branch power-line. While the cost of a horse and harness would probably be about $275, it should be remembered that the tractor has a portable power-plant that can be used for a great deal of farm-work that a horse cannot do. In short, there is every reason to believe that an electric outfit can be developed that can be used to advantage by a man with a small farm adjacent to a power-line.

TRAINING OF EMPLOYMENT MANAGERS UNDER GOVERNMENT AUSPICES

The first course of intensive training in employment management under Government supervision opened at the University of Rochester on March 26. The course lasted six weeks. Those taking the course comprise 20 prospective employment managers sent by manufacturers having war contracts. Laboratory work was provided in 15 factories at Rochester. The course was given at the request and under the supervision of the Industrial Service Sections of the several departments at Washington. The employment department of a modern manufacturing plant deals with human relations, such as legislation, safety, education, recreation, 'hiring and firing', discipline, pensions, sick benefits, etc. Other courses are to be given later in different parts of the country. Manufacturers that wish to send students for this training are asked to write to the Employment Managers' Division, 5207 New Interior Bdg., Washington, D. C. As far as possible, students will be chosen from these selections.

LARGE PUMPING PLANT ON CLEAR LAKE

The Yolo Water & Power Co. is constructing a pumping plant at the outlet of Clear lake, Lake county, California, that has several unusual features. Water from Clear lake flows down Cache creek, from which it is diverted by means of a system of canals and is used for the irrigation of a large body of land near Woodland, mostly devoted to rice culture. In ordinary years the normal flow of Cache creek has been sufficient for the needs of the farmers, but on account of the small rainfall and small resulting runoff last winter, the supply of water this season will be deficient. To obviate this difficulty arrangements have been made with

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the property-owners on the lake for their consent to lowering the lake-level by pumping to a point three feet below low-water mark.

The pumping plant will consist of seven Byron Jackson centrifugal pumps, each with two 30-in. suction-pipes and one 44-in. discharge. These pumps will work against a total head of 7 ft. and the aggregate capacity of the units will be 450 cu. ft. per second. The pumps will be belt-connected to seven distillate-engines having a total capacity of 700 hp. These engines are of several different makes as time of completion is an important factor, and it has been necessary to take whatever engines could be obtained from stock. The necessity for quick completion of the plant has also had a good deal to do with the adoption of belt-driving, since there has been no time for special construction to obtain the required speed from a given engine. The pumps will be placed above the water-level with the piping arranged siphon-fashion. It is expected that the plant will be completed about June 15.

THE KINNEY HEATER AND SPRAYER

The Kinney Manufacturing Co. has issued a new bulletin covering its Handy Heaters and Sprayers, sizes 50 and 150 gal., with hand-driven Kinney pump, and 300, 400, and 500 gal. with a gasoline-engine driven pump. These machines will heat, load, and spray under pressure any bituminous road material, including the heaviest grades of asphalt. They are being used by the Highway Commissions of California, New York, Pennsylvania, Massachusetts, and other States, by the United States government, and by many large cities including San Francisco and Los Angeles. Copies of this bulletin can be secured at the office of the Kinney Manufacturing Company, New Call Bdg., San Francisco.

KINNEY HEATER AND SPRAYER

WOOD IN MOTOR-TRUCK CONSTRUCTION

By CHARLES KELLY

Steel alone will not give the required elasticity to the frame of a motor truck. A combination of steel and wood is required to enable the frame to withstand shocks and vibration and prevent or reduce crystallization. Crystallization causes breakage. If a lining of wood, preferably oak, is fitted into the frame of a truck, the shock-absorbing qualities of the wood prevent crystallization of the metal in the frame. Another reason for using wood is that it permits the use of nuts and bolts with lock-washers inserted into holes drilled in the frame instead of rivets in punched holes. Punching damages the metal more than drilling. In hot riveting, a thin scale forms on the metal under the head of the rivet. Eventually this scale chips off, leaving the rivet loose. The working of the rivet enlarges the hole and causes vibration.

Book Review

Everyman's Chemistry: The Chemist's Point of View and his Recent Work Told for the Layman. By Ellwood Hendrick. Pp. 374, index, bibliography. Harper & Brothers, New York, 1917. For sale by 'Mining and Scientific Press,' San Francisco. Price, $2.

The popular scientific treatises by Mr. Hendrick are well known. They have been justly accepted by the public with the enthusiasm that the public always displays toward scientific subjects when presented clearly and brilliantly, couched in simple terms, and emanating from a person that can speak with authority. The book is thoroughly scientific in the sense that the development of the subject is along scientific lines. A man knowing no more chemistry than is contained in this book would have a very broad outlook upon the constitution of the world in which he lives, and he would better appreciate the complexities of modern industrial life and the needs of the Nation in stimulating and maintaining production of the many important essentials in War as it is conducted today. This is in no sense a war book, but its bearing upon the struggle should be very great, because it will help men who are not familiar with chemistry to obtain a grasp of the chemical bases of modern industrial life. The volume discusses air and water, the halogens, sulphur and its compounds, phosphorus, arsenic, antimony, bismuth, the alkali metals, sand and clay, lime and magnesia, iron and steel, and many metals both common and rare. With special facility the author undertakes to elucidate the principles of organic chemistry, starting with the carbon molecule and the simple hydro-carbon CH_4, from which he develops correctly the modifications that lead to the vastly complicated products of which there is no end. He promptly, however, comes to the

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practical application of organic chemistry in the discussion of olefins and acids, alcohol and some of its derivatives, fats, oils, sugar, starch, and gums. Cellulose and nitrogen compounds, the aromatic compounds, and the coal-tar derivatives constitute the remainder of the book, with the exception of some valuable appendices. In this discussion the author reveals the chemistry of the common things of life, such as industrial alcohol, soaps and their uses, cane and beet sugar, gums, varnishes, paints, bread-making, explosives, artificial silk, paper, benzol, picric acid and aromatics, and dyes. Any man with an ordinary high-school education will be able to read the book, and it is so delightfully written that it is a pleasure to read it. We would suggest that the technical men who happen to be identified with operations involving organic chemistry would find it a most useful and delightful means for reviewing the subject in the light of modern manufacture.

Engineering Societies

Idaho Society of Engineers. Ira F. Schaffner, secretary, Boise.

Los Angeles Section of American Society of Mechanical Engineers. Ford W. Harris, secretary, 1029 Higgins building.

Los Angeles Section of American Institute of Electrical Engineers. Edward Woodbury, secretary, 255 East 3rd street.

Oregon Society of Engineers. Orrin E. Stanley, secretary, room 409, City Hall, Portland.

Portland Section, American Institute of Electrical Engineers. Paul Lebenbaum, secretary, 45 Union Depot.

Portland Association of Members of American Society of Civil Engineers. J. A. Currey, secretary, 194 North 13th street, Portland.

San Francisco Section of American Society of Civil Engineers. N. A. Bowers, secretary, Rialto building.

San Francisco Section of American Society of Mechanical Engineers. Carl F. Braun, secretary, Hooker & Lent building.

San Francisco Section of American Institute of Electrical Engineers. A. G. Jones, 811 Rialto building.

Southern California Association of Members of American Society of Civil Engineers. Wilkie Woodward, secretary, 435 Consolidated Realty building, Los Angeles.

The annual meeting of the American Association of Engineers was held at Chicago May 14. The following officers were elected for the coming year: W. H. Finley, president; W. H. Clausen and L. K. Sherman, vice-presidents; Harold Almert, F. K. Bennett, T. M. Chapman, J. N. Hatch, Alexander Potter, and J. H. Prior, directors.

The San Francisco Section of the American Institute of Electrical Engineers met on May 24. William S. Leffler delivered an address on 'War Flying from an Engineering Standpoint,' and J. W. Beckman spoke on 'Electro-Chemistry and the Power Industry.'

A joint meeting of the Pacific Railway Club and the San Francisco Association of Members of the American Society of Civil Engineers was held May 29. William C. Edes, chairman of the Alaskan Engineering Commission, gave an illustrated lecture on 'Government Railroads in Alaska.'

A meeting of the Engineers' Club of San Francisco was held May 28 to discuss proposed amendments to the by-laws of the Club. An amendment permitting an increase in the proportion of non-engineer members of the club was defeated. An amendment establishing a junior grade of membership for engineers under 29 years old, with lower initiation fees and dues than for regular members, was adopted. Several minor amendments relating to the routine of election of new members were adopted.

Coming Conventions

American Society of Mechanical Engineers. Spring meeting, June 4-7, Worcester, Massachusetts.

National Municipal League. Annual meeting, June 4-6, New York.

American Institute of Chemical Engineers. Annual meeting, June 19-22, Berlin, New Hampshire.

American Concrete Institute. Annual meeting, June 27-29, Atlantic City, New Jersey.

American Society for Testing Materials. Annual meeting, June 25-28, Atlantic City, New Jersey.

American Institute of Electrical Engineers. Annual meeting, June 26-28, Atlantic City, New Jersey

Personal

Leon H. Hall has been appointed State engineer of Nevada.

J. L. Thayer, deputy county engineer for Lincoln county, Washington, has resigned to engage in the real estate business.

Robert L. Thomas, formerly city engineer of Eureka, California, is in charge of State highway construction between Eureka and Arcata.

H. J. Brunnier has gone to Washington to take charge of the Department of Concrete-Ship Construction for the Emergency Fleet Corporation.

T. R. Harrold, for several years deputy county surveyor for Fresno county, California, has been appointed county surveyor, succeeding the late Scott McKay.

Charles Evan Fowler, formerly of Seattle, but now making headquarters in New York, has received the honorary degree of Civil Engineer from Ohio State University.

George A. Kyle, engineer for the Siems-Carey Railway & Canal Co. in charge of the company's railroad work in China, who was captured by bandits on March 5, has been released.

C. H. Beal, petroleum technologist for the U. S. Bureau of Mines, who has been stationed in the Washington office for the past two years, has been transferred to the San Francisco office.

Frank A. Nikirk, assistant city engineer of San Jose, California, for the past two years, has been appointed city engineer, succeeding **G. Walter Hunt,** who resigned to enter the U. S. Naval Reserve.

M. J. Gavin, formerly chemist for the Shell Oil Co. of California, with headquarters at Oilfields, has been appointed assistant refinery engineer for the U. S. Bureau of Mines, with headquarters at San Francisco.

J. M. Wadsworth, petroleum engineer for the U. S. Bureau of Mines, with headquarters at San Francisco, has returned from a two months' trip to Washington and other Eastern cities, where has has been making fuel tests for the Bureau.

E. W. Wagy, petroleum tecrnologist for the U. S. Bureau of Mines, with headquarters at San Francisco, spent March and April in Colorado and the Mid-Continent fields, cooperating with State officials in making investigations of the conditions of the wells in the Boulder field.

Obituary

Scott McKay, for the past 16 years county surveyor of Fresno county, California, died of pneumonia at his home in Fresno May 9.

Robert Brinton Hall, of the British Royal Flying Squadron, was killed in France May 8. Before enlisting Mr. Hall was in charge of the accident-prevention work of the Portland Cement Association.

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Construction News Summary

STREET AND ROAD WORK

Astoria, Ore.—Contract for widening three miles of highway near city has been awarded to J. H. Tillman Co., Portland, for $21,307.72.

Calexico, Cal.—Contract for construction of topeka pavement on Hefferman avenue and on Second street has been awarded to Federal Construction Co., San Francisco, for $2761.83 and $9249.50, respectively.

Colfax, Wash.—Contract for construction of the Oakesdale-Garfield road, 1¾ miles, has been awarded to H. C. Marlott, 6526 17th avenue North-East, Seattle, for $16,942.53.

Eureka, Cal.—Elsemere & Jacobs were the only bidders for grading Henderson and T streets at $12,250. Bid was rejected.

Padgett & Kelly were the only bidders for improvement of alleys in business district at $2100 for macadamizing and $4290 for paving with concrete. Contract was awarded for macadam.

Fairfield, Cal.—Following bids were received for grading and paving part of the Napa road: Worswick Construction Co., $44,800 (awarded contract); Federal Construction Co., $48,000; Western Construction Co., $59,500.

Great Falls, Mont.—Contract for improvement of several streets has been awarded to S. Birch & Sons for $44,196.

Kirkland, Wash.—Contract for grading, graveling, and draining six miles of streets has been awarded to George Rerick, Kirkland, for $14,458.60. V. Bressi bid $16,603.90.

Los Angeles, Cal.—Contract for grading and paving Gramercy place between Temple and Third streets has been awarded to Bryant & Austin, Inc., 1656 Compton avenue, Los Angeles, for $33,711.53.

Contract for grading and paving Hooper street between 12th and Washington avenue has been awarded to Bryant & Austin for $12,451.37.

Contract for grading and paving Grand View avenue between 9th and 12th streets has been awarded to Fairchild-Gilmore-Wilton Co., Pacific Electric Bdg., Los Angeles, for $32,860.46.

Contract for grading and paving Van Ness avenue has been awarded to George R. Curtis, 2440 East 26th street, Los Angeles, for $34,863.12. Fairchild-Gilmore-Wilton Co. bid $35,836.97.

Contract for grading and construction of concrete pavement on Husted street has been awarded to William Liddington, 420 East 60th street, Los Angeles, for $3478.07.

Mesa, Ariz.—Contract for paving several streets has been awarded to Southwestern Concrete Co., Phoenix, for $96,000.

Missoula, Mont.—Following bids have been received by U. S. Forest Service for construction of 4.1 miles of highway west from Albertson: Ivanhoff Construction Co., Hamilton, $46,949; Clifton-Applegate-Tooele Co., Spokane, $62,740.50; Rajotte, Foberts & Winters, $65,025.50; Lord Construction Co., Hamilton, $66,524.90; A. L. Markhus, Ronan, $73,536.25; H. H. Boomer Co., Spokane, $77,025.

Nevada City, Cal.—All bids for road work near Newton have been rejected because too high and work will be readvertised.

Oakland, Cal.—Plans have been prepared by East Bay Water Co. for construction of new highway in San Pablo valley in place of the present highway, which will be flooded when the San Pablo dam is completed. Estimated cost is $100,000.

Olympia, Wash.—Contract for construction of Sunset highway between Summit and Easton has been awarded to Quigg Construction Co., Wenatchee, for $41,368. Engineers' estimate was $44,325.

Contract for construction of eight miles of the Central Washington highway near Sprague has been awarded to Spokane Bitu-Mass Co., Spokane, for $43,060.

All bids for construction of the Sunset highway from Kittitas east have been rejected because too high.

Pomona, Cal.—Contract for construction of 4-in. concrete pavement with ⅜-in. asphaltic surface on Philadelphia street has been awarded to Fleming Construction Co., Pomona, at $0.105 per sq. ft., or $15,000.

Porterville, Cal.—Contract for improvement of streets connecting business district with county highway system, which had been awarded to W. H. Paul for about $100,000, has been rescinded because of technicality, and work will be re-advertised.

Portland, Ore.—A. D. Kern was the only bidder at cost plus 15% for graveling 18 miles of State highway between Cascade Locks and Hood River.

Richmond, Cal.—Contract for surfacing Standard avenue has been awarded to Municipal Improvement Co., Richmond, for $4918.48.

Salt Lake City, Utah.—Contract for construction of 16,328 lin. ft. of concrete pavement near Logan has been awarded to P. J. Moran for $43,323.82. Other bidders were Olaf Nelson, $43,489.47; H. G. Gilkerson, $49,774.06; Strange & McGuire, $54,993.66; Wattis & Samuels, $58,012.34. Strange & McGuire also bid $58,280.30 for bitulithic pavement on a 4-in. crushed-rock base, and $56,622 for bitulithic with an asphaltic-concrete base. The State will furnish materials for this highway.

Contract for grading 6½ miles of highway in Spring canyon has been awarded to Bird & Bird, Springville, for $29,595.32. P. J. Moran, Salt Lake City, bid $46,828.21.

Contract for construction of bitulithic pavement on a 4-in. crushed-rock base on 3.7 miles of highway in Davis county has been awarded to Strange & McGuire, Salt Lake City, for $71,548.70. Bids were also received for concrete pavement as follows: J. W. Mellen, $73,059.16; P. J. Moran, $75,679.16; Olaf Nelson, $75,762.96; H. G. Gilkerson, $76,984.76; Parrott Bros., $78,605.16; Strange & McGuire, $83,886.56.

Contract for construction of 15,700 lin, ft. of reinforced concrete pavement from Ogden north has been awarded to P. J. Moran for $59,125.61. Other bidders were Olaf Nelson, $59,761.01; Wattis & Samuels, $62,058.21; H. G. Gilkerson, $64,000.91; Gibbons & Reed, $65,444.91; J. W. Mellen, $66,542.01; Parrott Bros., $66,995.66; Strange & McGuire, $73,937.71. Strange & McGuire also submitted bids on bitulithic pavement, ranging from $65,115 for bitulithic on 4-in. crushed-rock base to $78,146 for bitulithic on a 6-in. concrete base.

San Andreas, Cal.—All bids for construction of highway near Mokelumne Hill have been rejected and work has been postponed indefinitely.

San Francisco, Cal.—Contract for improvement of Silliman street between Bowdoin and Dartmouth streets has been awarded to Flinn & Treacy.

Contract for improvement of Lane street between McKinnon and Newcomb avenues and of McKinnon avenue between Lane and Mendell streets has been awarded to Flinn & Treacy.

Contract for improvement of Balboa street between 42nd and 43rd avenues has been awarded to Owen McHugh.

Board of Public Works has awarded the following contracts for street work:

Fairfax avenue between Keith and Lane streets to D. J. Counihan.

38th avenue between Balboa and Cabrillo streets to C. B. Eaton.

Judah street between 16th and 17th avenues to Blanchard-Brown Company.

Kansas street between 17th and Mariposa streets to Blanchard-Brown Company.

Eighth street near Mission street to Frank O'Shea.

Castro street near Alvarado street to Frank O'Shea.

15th avenue between Cabrillo and Fulton streets to S. F. Johnson.

California street between 27th and 28th avenues to S. F. Johnson.

Hearst avenue between Genesee and Hamburg streets to Flinn & Treacy.

Niagara avenue between Mission street and Huron avenue to Flinn & Treacy.

Bids will be received until June 6 by State Board of Harbor Commissioners for paving parts of the Embarcadero.

Santa Ana, Cal.—County surveyor J. L. McBride has submitted report on cost of grading and paving highway through Santa Ana canyon. Estimated cost is from $57,000 to $83,500, according to route chosen.

County surveyor J. L. McBride has reported that the cost of grading a highway from Newport bay to Laguna Beach along the coast, eight miles, would be $76,000.

Santa Barbara, Cal.—Contract for improvement of part of California street has been awarded to Fairchild-Gilmore-

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Wilton Co., Los Angeles, at the following unit prices: 5-in. concrete pavement, including grading, $0.25 per sq. ft.; concrete curbs, $0.50 per ft.; re-setting stone curb, $0.20 per ft.; concrete sidewalks, $0.14 per square foot.

Seattle, Wash.—Contract for construction of concrete sidewalks on 10th avenue North-East and other streets has been awarded to W. H. Smith, 1212 North 39th street, Seattle, for $4898.95.

Contract for construction of concrete sidewalks on Evanston avenue has been awarded to W. H. Smith for $2218.75.

Bids will be received until June 17 by county commissioners for grading 0.47 mile of highway in Green river valley. Estimated cost is $4600.

E. J. Macquaid was only bidder at $22,000 for construction of the Decker road. Bid was rejected because too high.

Contract for improvement of Sixth avenue North has been awarded to W. A. Kupoff for $5387.50.

Contract for construction of concrete pavement on the Hindle road has been awarded to J. L. Smith, 1620 Third avenue, Seattle, for $21,000. R. M. Hardy bid $22,700. Engineer's estimate was $18,291.28.

South Pasadena, Cal.—Contract for grading and construction of oil-macadam pavement on Brunswick avenue has been awarded to Wells & Bressler, Santa Ana, for $6317.09.

Stockton, Cal.—Plans have been approved for formation of road improvement district west of city. Improvements include grading and construction of concrete curbs, gutters, and sidewalks, and oil-macadam pavement. Estimated cost is $29,871.

Tacoma, Wash.—Contract for widening four miles of the road to Camp Lewis has been awarded to F. M. Morgan, Everett, for $96,385.

Visalia, Cal.—Contract for construction of Porterville-Woodville highway has been awarded to Concrete Pipe & Construction Co., Porterville.

Yakima, Wash.—Contract for construction of 39,080 sq. yd. of concrete pavement on four miles of the Riverside road has been awarded to A. J. Gudgel, Missoula, Montana, for $86,383.70.

Contract for construction of 14,230 sq. yd. of concrete pavement on permanent highway No. 26-A has been awarded to the Yakima Glazed Cement Paving Co. for $28,198.

Contract for paving 7½ miles of the Yakima-Moxee City highway has been awarded to the Washington Paving Co., 309 First avenue South, Seattle, for $200,000.

SEWERS AND DRAINAGE

Anaheim, Cal.—Contract for construction of Imhoff tank for municipal sewage-disposal plant has been awarded to C. McNeil, Santa Ana, for $4137. Other bidders were J. P. Hunter, $4500; Wells & Bressler, $4750; Orange County Engineering Construction Co., $5000.

Los Angeles, Cal.—M. S. Cummings, 1302 West 22nd street, Los Angeles, was low bidder and was awarded contract at $83,000 for construction of a cement-pipe and cast-iron pipe sanitary sewer on Glassell avenue. Other bidders were George R. Curtis, $89,000; Peter S. Tomich, $90,000; Mike Chutuk, $94,000.

Petaluma, Cal.—Contract for construction of sewer on Post and English streets has been awarded to Schlunneger Bros., Petaluma, for $702.30.

Renton, Wash.—Contract for construction of lateral sewer has been awarded to G. B. Benjamin, Seattle, for $1171.

San Diego, Cal.—Following bids have been received for construction of sewer at North island: W. E. Hampton Co., $12,490; Greville-Brockway Construction Co., $12,780; C. H. Julian, $17,144; Lange & Bergstrom, $17,500.

Contract for construction of reinforced concrete Imhoff tank at the county tubercular hospital has been awarded to L. E. C. Smith for $2240.

Stockton, Cal.—A. E. Burns was the only bidder and was awarded contract at $1869 for construction of 1500 ft. of sanitary sewer along Fair Oaks avenue. Engineer's estimate was $1487.

BRIDGES AND CULVERTS

Astoria, Ore.—Bids will be received until June 8 by county clerk for construction of several wooden bridges.

Eureka, Cal.—Bids will be received until June 11 by Fred M. Kay, county clerk, for construction of reinforced concrete approaches to the concrete bridge over Eel river at Fernbridge.

Hood River, Ore.—Contract for construction of bridge over east fork of Hood river has been awarded to L. M. Bentley, Hood River, for $4338, and $10.25 per cu. yd. for extra concrete.

Modesto, Cal.—Contract for construction of bridge across Dry creek near Waterford has been awarded to C. E. Cotton for $38,940.

Contract for construction of bridge across Rock creek has been awarded to H. W. McAuley for $6829.

Mt. Vernon, Wash.—J. R. Wood, Seattle, was low bidder at $17,608 for construction of Jackman Creek bridge. Coast Bridge Co. bid $18,127 and R. E. Meath $18,800. All bids were rejected because too high.

S. Norris, Burlington, was low bidder at $4168 for construction of 90-ft. wooden Howe truss bridge across Samish river. Skagit Construction Co. bid $6857 and Anacortes Pile Driving Co. $7019. All bids were rejected because too high.

Sacramento, Cal.—Following bids were received by State Highway Commission for construction of reinforced concrete bridges in Shasta county:

Bridges across Castle, Mears, and Flume creeks, length 120, 45, and 30 ft., respectively: Bordwell & Zimmerman, Calistoga, $13,726.25; May & Soult, Napa, $13,741; A. H. Vogt, San Francisco, $17,000; J. A. Marshall, Berkeley, $17,900; Connors & Green, Eureka, $22,300. Engineers' estimate was $15,417.55.

Bridges across Slate and Doney creeks, length 60 and 30 ft., respectively: J. Fitzpatrick, Sacramento, $10,780; J. A. Marshall, $13,000; A. H. Vogt, $13,975. Engineers' estimate was $9355.69.

Bridges across Sulphur, Boulder, Churn, Salt, Moody, and Spring Branch creeks, length 80, 46, 230, 45, 45, and 45 ft., respectively: J. A. Marshall, $31,490. Engineers' estimate was $27,275.68.

San Jose, Cal.—Bos & O'Brien, Hearst Bdg., San Francisco, were the only bidders for construction of bridge over Coyote creek at Santa Clara street at $79,200 or $67,400 if city would furnish cement. Bid was rejected.

Seattle, Wash.—Bids will be received until June 10 by county commissioners for construction of 96-ft. steel bridge across south fork of Snoqualmie river at North Bend. This is the second time that this work has been advertised.

Spokane, Wash.—Contract for construction of the Nine Mile bridge has been awarded to C. L. Graves, Spokane, for $32,900. Illinois Steel Bridge Co., bid $33,420, and Portland Bridge Co., $33,698.

Vancouver, B. C.—Contract for construction of bridge over Capilano river has been awarded to Robertson & Partners, Ltd., Vancouver, for about $50,000.

Waterville, Wash.—Bids will be received until June 7 by county commissioners for construction of a six-bent frame-trestle.

Bids will also be received until the same time for construction of a 40-ft. reinforced concrete arch-bridge over Corbaley creek at Orondo.

Wilkensen, Wash.—Contract for construction of 60-ft. reinforced concrete arch-bridge over Gale creek has been awarded to H. C. Malott, 6526 17th avenue, North-East, Seattle, for $7500.

IRRIGATION AND WATER SUPPLY

El Centro, Cal.—All bids for construction of wooden waste-gate near Calexico for Imperial irrigation district have been rejected.

Modesto, Cal.—A. L. Wiley, Boise, Idaho, will make investigation of Don Pedro dam-site on behalf of Modesto and Turlock irrigation districts.

Placerville, Cal.—State Railroad Commission has decided that the El Dorado Water Users' Association has equal rights with the Western States Gas & Electric Co. in the waters of several lakes in Eldorado and Alpine counties. This order is conditional upon the association constructing an irrigation system before the company constructs a proposed power-plant.

San Francisco, Cal.—State Water Commission has received the following applications for permission to divert water for irrigation:

Waterford irrigation district, Waterford, 150 second-feet from Tuolumne river. Plans include pumping-plant and canals. Pumps are to be used for an auxiliary supply when the regular gravity supply from Lagrange dam is insufficient. Estimated cost is $175,000.

Horne Development Co., Inc., Auburn, 20 second-feet from creeks in Lassen county. Plans include canals and two earth dams. Estimated cost is $71,000.

A. Granauer, Tracy, 300 second-feet from San Joaquin river for a proposed irrigation district containing 30,000 acres, the point of diversion being 12 miles west of Modesto.

C. L. Lemm and J. G. Chatham, Bella Vista, 80 second-

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feet from Montgomery creek. Plans include main ditch three miles long. Estimated cost is $10,000.

Hastings Tract Co., 141 Sutter street, San Francisco, 600 second-feet from Lindsay slough in Solano county. Plans include motor-driven pumping plant and ditches.

J. J. and C. H. Rodenkirk, Dyer, Nevada, 5½ second-feet from creeks in Mono county. Plans include reinforced concrete dam and 33,000 ft. of pipe-line.

Charles T. Ross, San Francisco, 45,000 acre-feet from creeks in Amador and Eldorado counties.

Santa Barbara, Cal.—Bent Bros., Los Angeles, were low bidders and were awarded contract at $342,981 for construction of Gibraltar dam. Other bidders were R. C. Storrie & Co., $388,430; Rolandi & Monk, $426,120; Ross Construction Co., $435,860. Work will require 45,000 cu. yd. of concrete. City will furnish cement. The estimated time for completion ranges between 450 and 500 days.

Tracy, Cal.—Extension of system of West Side irrigation district to cover 10,000 acres of land south of present district is proposed.

LIGHT, HEAT, AND POWER

Ontario, Cal.—Ontario Power Co. will construct new power-house. Estimated cost is $60,000.

San Francisco, Cal.—State Water Commission has received the following applications for permission to divert water for power:

Nevada-California Power Co., Riverside, 12 second-feet from Birch creek in Inyo county for use at existing power-plants No. 2, 3, and 4. Estimated cost of work is $42,500.

Southern Sierras Power Co., Riverside, 12 second-feet from Brick creek for use at existing plants No. 5 and 6. Estimated cost of work is $42,500.

E. E. Lindsay, San Francisco, 30 second-feet from Bucks creek in Plumas county. Plans include timber-crib dam and flume and ditch four miles long. Estimated cost is $153,000.

RIVER AND HARBOR WORK

Honolulu, Hawaii.—Contract for construction of breakwater at Raymond has been awarded to Hawaiian Dredging Co., Honolulu, for $150,000.

Long Beach, Cal.—Contract for dredging at harbor has been awarded to John F. Craig, Long Beach, for $18,000.

Newport Beach, Cal.—Ross Construction Co., Sacramento, was low bidder at 16.75c. per sq. yd. for dredging in harbor. Los Angeles Dredging Co. bid 20 cents.

Oakland, Cal.—Director of Railroads W. G. McAdoo has consented to the removal of Long wharf by the Southern Pacific Co. and the construction of other wharves in its place south of the present Oakland mole. Estimated cost is $400,000.

Portland, Ore.—J. A. McEachern Co. was low bidder for construction of timber trestle for carrying water-main at municipal wharf at St. Johns for $0.50 per ft. for piles and $58 per M.B.M. for lumber in place. Edward Sandeberg bid $0.90 and $84 and Portland Bridge & Building Co. bid $1.30 and $70.

Richmond, Cal.—American Dredging Co., 255 California street, San Francisco, was low bidder and will be awarded contract at $0.0983 per cu. yd. for dredging channel at harbor. San Francisco Bridge Co. bid $0.102. Standard American Dredging Co. offered to rent a dredge for $600 per day. There is $100,000 available from the initial appropriation for the work and $456,000 in all.

San Diego, Cal.—San Francisco Bridge Co., Nevada Bank Bdg., San Francisco, was the only bidder at $84,000 for construction of marine railway at the naval coal-depot.

San Francisco, Cal.—Contract for making repairs to wharves at U. S. Transport Docks has been awarded to Thompson Bridge Co., 103 Main street, San Francisco, for $2815.

Bids will be received until June 6 by the Board of State Harbor Commissioners for construction of pier-shed and connecting buildings for piers No. 29 and 31. Plans from State Board of Harbor Commissioners, upon deposit of $20.

Contract for furnishing and operating a dredge on the Sacramento and San Joaquin rivers for the California Debris Commission has been awarded to Caledonia Dredging Co., San Francisco.

Watsonville, Cal.—Haviland & Tibbetts, Alaska Commercial Bdg., San Francisco, have completed report on proposed flood-protection system for southern part of city. The estimated cost of the levee is $13,500 and of the right-of-way is $24,000, making a total of $37,500.

RAILROAD WORK

Astoria, Ore.—Plans are being prepared for Port of Astoria Commission for construction of belt-line railroad. Estimated cost is $82,000.

Spokane, Wash.—Contract for filling the Rosalia trestle on the Spokane & Inland railroad has been awarded to Grant-Smith Co., Henry Bdg., Seattle. Work will require 60,000 cu. yd. embankment.

Washington, D. C.—Railroad Administration has prepared plans for the expenditure of $938,000,000 by the railroads of the country on additions, betterments, and equipment. The following amounts are assigned to Western railroads: Santa Fe, $41,465,000; Union Pacific, $30,397,000; Southern Pacific, $29,432,000; Salt Lake Route, $1,870,000; Northern Pacific, $14,050,000; Northwestern Pacific, $1,000,000; Spokane, Portland & Seattle, $488,000; Western Pacific, $5,126,000.

BUILDING CONSTRUCTION

Alameda, Cal.—Contract for construction of building for Union Iron Works has been awarded to Palmer & Peterson, Monadnock Bdg., San Francisco, for $54,956.

L. S. Rosener, Insurance Exchange Bdg., San Francisco, is preparing plans for steel and frame plate-shop for Moore Shipbuilding Co. Work will be done by day-labor. Estimated cost is $39,000.

Arcadia, Cal.—War Department will construct balloon camp. Estimated cost is $400,000.

Arcata, Cal.—L. G. Bergren & Son, San Francisco, were low bidders at $60,700 for construction of brick-and-frame high-school building.

Bremerton, Wash.—Federal Government will spend $2,500,000 on construction of dwellings for employees at Puget Sound Navy Yard.

Burlingame, Cal.—Contract for construction of concrete building for E. M. and G. W. Gates has been awarded to I. W. Coburn, 180 Jessie street, San Francisco for $33,000.

Concord, Cal.—P. M. Sanford, Richmond, was low bidder at $22,908 for construction of high-school building. Thomas J. Kennedy, Martinez, was low bidder at $5095 for plumbing and heating.

Fresno, Cal.—Contract for remodeling Farmers' National Bank building has been awarded to Emmett Riggins, Fresno, for $30,000.

Macdonald & Kahn, who have contract for construction of buildings for California Associated Raisin Co., have sublet the concrete work to Palmer & Peterson, San Francisco. Estimated cost is $150,000.

Hemet, Cal.—Most of the property-owners here and at San Jacinto, whose buildings were destroyed by the recent earthquake, are planning to re-build with concrete or reinforced concrete.

Isleton, Cal.—Contract for construction of two-story apartment and store-building for F. W. Gardiner has been awarded to H. F. Smith, Walnut Grove, for $12,000.

Klamath Falls, Ore.—Contract for construction of new courthouse, which had been awarded to J. M. Dougan Co., Portland, has been annulled by a court decision.

Knights Landing, Cal.—California Producers' Exchange will construct grain-elevator.

Los Angeles, Cal.—Contract for construction of a reinforced concrete machine-shop and a hollow-tile service building for American Can Co. has been awarded to Leonardt & Peck, H. W. Hellman Bdg., Los Angeles, for $60,000.

Contract for construction of brick building for Hollywood high-school has been awarded to Willard-Brent Co., Baker-Detwiler Bdg., Los Angeles, for $57,797.

Los Gatos, Cal.—First National Bank will construct one-story brick and terra cotta building.

Manteca, Cal.—Contract for construction of brick building for Bank of South San Joaquin has been awarded to D. Baysinger, Manteca, for $10,497.

Menlo Park, Cal.—Contract for construction of frame building for J. C. Brown has been awarded to F. Miller, 225 Dolores street, San Francisco, for $10,500.

Napa, Cal.—Contract for construction of brick and reinforced concrete building for First National Bank has been awarded to Herndon & Finnegan, Sacramento, for $15,000.

Oakland, Cal.—Maurice Couchot, 110 Jessie street, San Francisco, is preparing plans for reinforced concrete factory-building to be erected by V. K. Sturges at Foothill boulevard and Stanley road. Estimated cost is $100,000.

Contract for construction of class A building for Pacific Telephone & Telegraph Co. has been awarded to J. M. Dougan, Hearst Bdg., San Francisco, for $200,000.

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Palo Alto, Cal.—Krafft & Son, Phelan Bdg., San Francisco, are preparing plans for construction of two-story frame apartment-house for C. E. Cumberson. Estimated cost is $25,000.

Porterville, Cal.—Contract for construction of two-story apartment-house for W. J. Podley has been awarded to J. B. Dawson, Los Angeles, for $20,000.

Rio Vista, Cal.—All bids for construction of high-school building have been rejected. New call for bids will be issued in about six months.

Sacramento, Cal.—Bids will be received until June 11 by W. F. McClure, State engineer, for completion of main building at Humboldt State Normal School. Plans from State engineer upon deposit of $10.

Louisiana State Rice Milling Co. will construct rice-mill in West Sacramento. Estimated cost is $250,000.

State Board of Control has announced that construction of new State buildings at Sacramento and other construction work, except highways and work necessary to protect public health or as a measure of safety, will be postponed until after the War.

Bids will be received until June 7 by W. F. McClure, State engineer, for plumbing, heating, and ventilating, gas fitting, and sewers for main building at Humboldt State Normal School at Arcata.

All bids for placing concrete roof on pumping-plant at city waterworks have been rejected.

Salt Lake City, Utah.—Schuyler & Sorenson were low bidders at $61,700 for construction of the Irving school.

San Diego, Cal.—Walter Slater Co., Los Angeles, was low bidder at $23,400 for construction of a quartermasters' school at Rockwell field. Other bidders were Lange & Bergstrom, $25,200; Chisholm & Jackson Construction Co., $25,893; Pacific Building Co., $26,105; W. E. Kier Construction Co., $27,897; J. M. Anderson, $28,894.

San Francisco, Cal.—Toyo Kisen Kaisha Steamship Co. will construct building on Market street opposite Sansome. O'Brien Bros., 240 Montgomery street, San Francisco, are architects.

Contract for construction of one-story addition to building at Grant avenue and Sutter street owned by the White House, Inc., has been awarded to M. V. Brady, Monadnock Bdg., San Francisco, for $100,000.

Contract for construction of mill-construction warehouse at Clay and Battery streets for H. P. Bowie has been awarded to H. S. Williams, Hearst Bdg., San Francisco, for $33,000.

Contract for construction of reinforced concrete shop-building for Isabella Fowler has been awarded to J. E. Beck, 110 Jessie street, San Francisco.

Contract for construction of brick store-building for C. C. Dennigan at Geary and Williams streets has been awarded to C. T. Merchant, 180 Jessie street, San Francisco, for $10,000.

Contract for construction of several buildings at Fort Mason has been awarded to Shattuck-Edinger Co., 525 Market street, San Francisco, on a cost-plus-percentage basis.

Contract for construction of concrete building for Philippine Vegetable Oil Co. on Japan street near Townsend has been awarded to Barrett & Hilp, Sharon Bdg., San Francisco, for $12,500.

Contract for construction of reinforced concrete building for Warehouse Investment Co. has been awarded to Lindgren Co., Monadnock Bdg., San Francisco, for $200,000.

San Jose, Cal.—J. S. Bogart, Mills Bdg., San Francisco, is preparing plans for class A factory-buildings for Figprune Cereal Co. Estimated cost of first unit is $60,000 and of all the buildings $200,000.

Contract for construction of brick apartment-house for C. J. Vath has been awarded to Z. O. Field, 167 South 14th street, San Jose, for $22,941.

Contract for construction of brick building for N. Gondolf at Market and St. James streets has been awarded to R. O. Summers, 17 North First street, San Jose, for $12,000.

A. C. Bliss, Los Angeles, is preparing plans for concrete and hollow-tile cannery-buildings for California Fruit Growers' Association. Estimated cost is $250,000.

Contract for construction of brick-and-concrete warehouse for Smith-Patton Co. has been awarded to Frank P. Hoyt for $20,000.

San Pedro, Cal.—Contract for construction of barracks for Coast Artillery has been awarded to William Simpson Co., Marsh-Strong Bdg., Los Angeles. Estimated cost is $200,000.

Southwestern Shipbuilding Co. will construct several frame buildings. Estimated cost is $22,460.

Santa Ana, Cal.—Contract for construction of frame-and-plaster packing-house for Santa Ana Walnut Association has been awarded to Kidder & Shipp, Santa Ana, for $20,495. Other bidders were as follows, the first figure being for plaster exterior and the second for rustic: George Kuechel, $21,505 and $20,205; A. E. Bird, $22,400 and $21,000; E. W. Smith, $22,700 and $21,155; G. E. Preble, $23,712 and $22,312; Bishop & Cole, $25,267 and $24,849. Henry Clark Construction Co. bid $27,289.75 and $27,590.75, including roofing, which was not included in the other bids. Contract for roofing was awarded to Johns-Manville Co. for $1380.40.

Seattle, Wash.—Contract for construction of frame machine-shop for Heffernan Engine Works has been awarded to Hull Building Co., 1510 Jefferson street, Seattle, for $25,000.

Gulowsen-Grei Engine Co., Alaska Bdg., Seattle, will construct factory-buildings at Salmon bay. Estimated cost is $400,000. S. E. Sonnichsen, Downs Block, Seattle, is architect.

Fred A. Wilson is preparing plans for building for flour-mill, warehouse, and offices for Centennial Milling Co. Estimated cost is $400,000.

Selma, Cal.—Contract for construction of packing-house for California Associated Raisin Co. has been awarded to Trewhitt & Shields, Fresno.

Stockton, Cal.—Contract for construction of hollow-tile apartment-house for W. H. Bennett has been awarded to Reilly & Murphy, Stockton, on a cost-plus-percentage basis. Estimated cost is $110,000.

Woodland, Cal.—W. H. Weeks, 75 Post street, San Francisco, is preparing plans for alterations and additions to brick building owned by Porter Estate. Estimated cost is $65,000.

BONDS

Corcoran, Cal.—Bond issue of $66,000 for improvement and extension of water system is proposed. L. M. Stone is engineer.

Esparto, Cal.—Bond issue of $12,000 has been voted for construction of water system, including well, tank, and distributing system.

Fresno, Cal.—Bids will be received until June 12 by D. M. Barnwell, county clerk, for the purchase of $30,000 worth of bonds of the Firebaugh school district. These bonds bear 6% interest.

Globe, Ariz.—Bond issue of $240,000 for construction of sewer system has been sold to Powell, Garard & Co., Chicago.

Modesto, Cal.—Election will be held on June 10 to vote on bond issue of $110,000 for construction of school buildings.

Election has been called for June 11 in Modesto irrigation district to vote on bond issue of $75,000 for construction of drainage ditches.

Olinda, Cal.—Election has been called for June 7 in Happy Valley irrigation district to vote on bond issue of $615,000 for extensions and improvements to irrigation system.

Princeton, Cal.—Bond issue of $175,000 has been voted in the Princeton-Codora-Glenn irrigation district for purchase of part of the canals of Sacramento Valley Irrigation Company.

Santa Ana, Cal.—Bids will be received until June 5 by W. B. Williams, county clerk, for the purchase of $12,000 worth of bonds of the La Habra school district.

Bond issue of $46,200 for construction of bridges has been sold to the Farmers & Merchants National Bank of Santa Ana for par and accrued interest.

Ukiah, Cal.—Bond issue of $10,000 for enlargement of outfall sewer and construction of septic tank has been voted.

MACHINERY AND SUPPLIES

Hanford, Cal.—City has purchased 400 ft. of 1½-in fire-hose from the Pyrene Manufacturing Co. for 65c. per foot.

Los Angeles, Cal.—Contract for furnishing and laying 4370 ft. of 12-in. cement pipe in San Fernando valley has been awarded to Valley Concrete Pipe Co., Van Nuys, at $0.54 and $0.55 per foot.

Martinez, Cal.—Following contracts have been awarded for furnishing materials for county highway work: Crushed rock and screenings to Blake Bros. Co., Oakland, and Natomas Consolidated Co., Sacramento. Sand to River Rock & Gravel Co., Stockton. Cement to Henry Cowell Lime & Cement Co., San Francisco.

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